RADIO NEWS

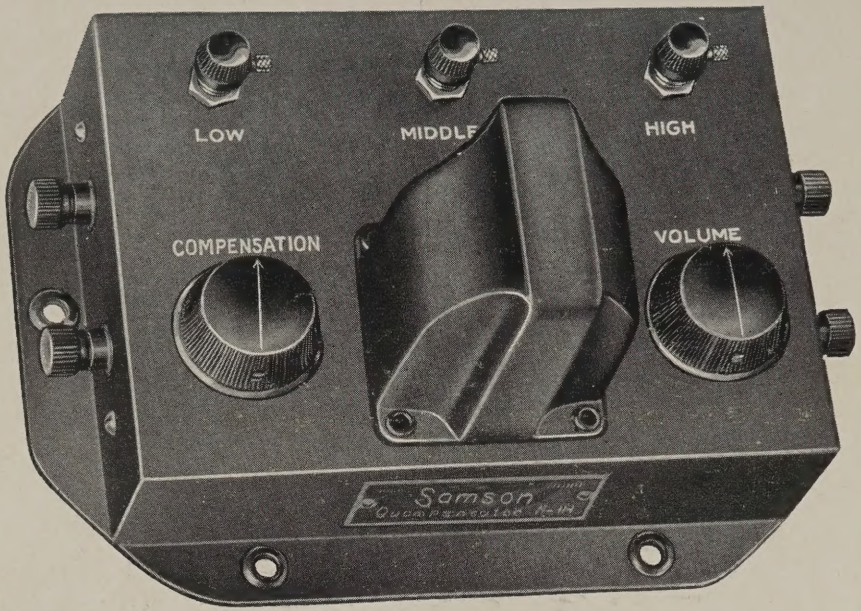
MAY
25 CENTS

More About Pentodes

Transmitting Tubes
See Page 990

Auto, Plane
and Motor Boat Radio

DAVID
HYMES 30



Samson Qualpensator

varies tone quality to satisfy anyone anywhere

This unit makes it possible to please everyone with reproduction from radio set or magnetic phonograph pickup.

The Qualpensator is a quality compensator and volume control for attachment to either of the above and for other special applications.

Some like the bass notes emphasized; others prefer them softened. Still others prefer the treble, others both treble and bass notes, or even the middle register notes modified to their taste.

The Qualpensator will vary tone quality to please in any one of these ranges. Simply turn a switch and adjust the knob for degree of change desired.

You can remove phonograph needle scratch, a heterodyne whistle or compensate for the partial deafness of your listener. The Samson Qualpensator will do much to compensate for the poor acoustical properties of a room.

Hearing Is Believing

Dealers: Here is a great opportunity to sell a device on a money-back guarantee. Every prospect to whom we have demonstrated the Qualpensator has bought one or more. Send for operating instruction bulletin No. RN8.

And the price is right. Only $25.00, and *immediate delivery.*

Samson Electric Co.

MEMBER
R.M.A.

Main Office:
CANTON, MASS.

Factories: CANTON
and WATERTOWN, MASS.

5,000 Radio Service Men *Needed Now!*

The replacing of the old battery operated receivers with all-electric Radios has created a tremendous country-wide demand for expert Radio Service Men. Thousands of trained men are needed *quick!*

$40 *to* $100 *a week* Full Time
$3.00 *an hour* Spare Time

30 Days of R.T.A. Home Training

. . . enables you to cash in on this latest opportunity in Radio

Ever on the alert for new ways of helping our members make more money out of Radio, the Radio Training Association of America now offers ambitious men an intensified training course in Radio Service Work. By taking this training you can qualify for Radio Service Work in 30 days, earn $3.00 an hour and up, spare time; prepare yourself for full-time work paying $40 to $100 a week.

More Positions Open Than There Are Trained Men to Fill Them

If you were qualified for Radio Service Work today, we could place you. We can't begin to fill the requests that pour in from great Radio organizations and dealers. Members wanting full-time positions are being placed as soon as they qualify. 5,000 more men are needed *quick!* If you want to get into Radio, earn $3.00 an hour spare time or $40 to $100 a week full time, this R. T. A. training offers you the opportunity of a lifetime.

We furnish you with all the equipment you need to become a Radio Service Man!

Radio Service Work a Quick Route to the Big-Pay Radio Positions

Radio Service Work gives you the basic experience you need to qualify for the big $8,000, $10,000 to $25,000 a year Radio positions. Once you get this experience, the whole range of rich opportunities in Radio lies open before you. Training in the Association, starting as a Radio Service Man, is one of the quickest, most profitable ways of qualifying for rapid advancement.

If you want to get out of small-pay, monotonous work and cash in on Radio quick, investigate this R. T. A. training and the rich money-making opportunities it opens up. No special education or electrical experience necessary. The will to succeed is all you need.

Mail Coupon for No-Cost *Training Offer*

Cash in on Radio's latest opportunity! Enroll in the Association. For a limited time we will give to the ambitious man a No-Cost Membership which need not . . . should not. . . cost you a cent. But you must act quickly. Filling out coupon can enable you to cash in on Radio within 30 days, lift you out of the small-pay, no-opportunity rut, into a field where phenomenal earnings await the ambitious. You owe it to yourself to investigate. Fill out coupon NOW for details of No-Cost Membership.

The Radio Training Association of America
4513 Ravenswood Ave. Dept. RN-5, Chicago, Ill.

The Radio Training Association of America
4513 Ravenswood Ave., Dept. RN-5, Chicago, Ill.

Gentlemen: Please send me details of your No-Cost training offer by which I can qualify for Radio Service Work within 30 days. This does not obligate me in any way.

Name ....

Address ....

City .... *State* ....

Radio News

Vol. XI CONTENTS FOR MAY, 1930 No. 11

ARTHUR H. LYNCH, Editorial Director
JOHN B. BRENNAN, JR.
Technical Editor
STUART C. MAHANAY
Managing Editor
EDWARD W. WILBY
Associate Editor

In Radio News Next Month

A Special Short-Wave Number

Feature Articles by

Hiram Percy Maxim
Dr. Lee De Forest
Lieut. Wm. H. Wenstrom
James Millen
Capt. John Irwin
Robert Hertzberg

George E. Fleming will begin a series of articles of the Loftin-White Laboratories on a history of the Loftin-White system.

Edward Wilby describes the RADIO NEWS version of Lieut. Wenstrom's "Cornet" short-wave receiver.

Complete call list of all short-wave broadcasting stations, together with their time schedules.

Complete constructional details for building the latest type of short-wave transmitter and receiver.

Cover—From a Painting by David Hymes PAGE
Frontispiece: Dr. Lee De Forest.......... 976
Editorial 978
How to Build a Flyweight Portable Receiver for Plane, Glider or Outboard Motorboat 980
Tying Up Radio with Sunspots.......... 984
An analytical discussion of their relationship, by LIEUT. WM. H. WENSTROM
A Sea-Going Radiophone.......... 988
A unique, limited-range short-wave telephone for all types of boats, by WILLIAM JONES
Evolution of the Vacuum Tube.......... 990
An outline of history of one of the most important developments in the radio industry by DR. LEE DE FOREST
Current Comment 992
By STUART C. MAHANAY
Constructional Details for the Universal Auto Receiver.......... 994
An outfit of particular interest to the serviceman, by WALTER H. BULLOCK
A Historic Rescue.......... 997
Commemorating the eighteenth anniversary of the Titanic disaster, by ORRIN E. DUNLAP
Build This One-Tube Tuner for Your Loftin-White Amplifier.......... 998
Assembly details for a tuner especially designed for the Loftin-White System, by JOHN B. BRENNAN, JR.
Analyzing the Hum.......... 1002
The fourth of a series outlining scientific methods of hum elimination, by BENJAMIN F. MIESSNER
Some Notes on the Practical Operation of Direct-Coupled Amplifiers.......... 1004
An outline of the points of superiority of the Loftin-White System, by COMMANDER E. H. LOFTIN and S. YOUNG WHITE
Analyzing Receiver Distortion.......... 1006
A discussion of the factors which influence tone quality, by R. M. SOMERS
Radio in Every Room.......... 1008
Hotels and apartments, everywhere, are making radio programs available in every room, by S. GORDON TAYLOR
Behold! The Decibel.......... 1010
An explanation, for the layman, of this comparatively new engineering term, by C. STERLING GLEASON
The High Road to Adventure.......... 1012
Unlimited opportunities lie ahead for trained radio men, by LOUIS L. CREDNER
Flying by Radio Beacon.......... 1014
Radio beacon and other radio aircraft developments are playing an important part in the development of aviation, by CAPTAIN JOHN R. IRWIN
A Modern Miracle.......... 1015
How the Majestic organization has grown in the past three years
A Set-Tester de Luxe.......... 1016
Constructional details for building a highly-efficient, yet inexpensive, receiver-analyzer, by GEORGE E. FLEMING
Brickbats and Bouquets.......... 1018
A Compact Auto Receiver.......... 1019
By GILBERT G. BROWN
Make Your Precision Tests and Measurements with a Vacuum Tube Voltmeter.......... 1022
By JOSEPH I. HELLER
The Junior Radio Guild.......... 1024
RADIO NEWS Information Sheets.......... 1026
RADIO NEWS Manufactured Receiver Circuits.......... 1028
News from the Manufacturers.......... 1030
RADIO NEWS Home Laboratory Experiments.......... 1031
The Radio Forum.......... 1033
Index to Advertisers.......... 1066

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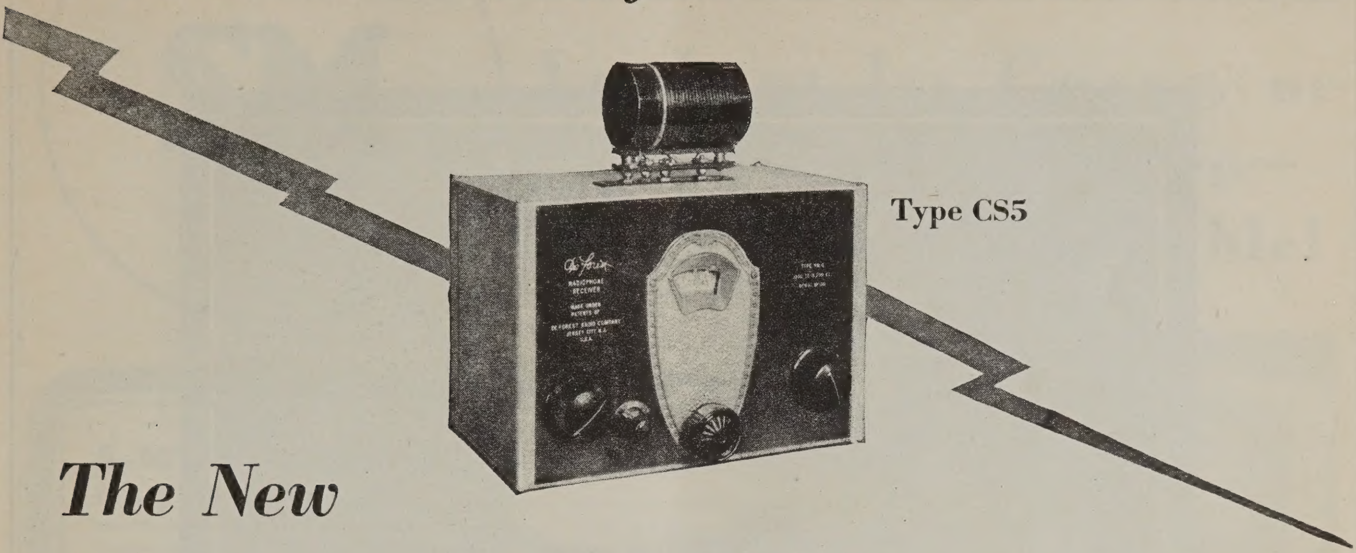
The latest achievement of the De Forest Laboratories



Type CS5

The New

DE FOREST SHORT WAVE RECEIVER

TRANSMITTING AUDIONS

510	—15 Watt Oscillator	$ 9.00
503A	—50 Watt Oscillator and R. F. Power Amplifier	40.00
511	—50 Watt Oscillator, R. F. Amplifier, Modulator or R. F. Power Amplifier	40.00
545	—50 Watt A.F. Amplifier and Modulator	45.00
552	—75 Watt Oscillator and R. F. Amplifier	32.50
504A	—250 Watt Oscillator, Modulator or R. F. Power Amplifier	140.00
500	—500 Watt Special Oscillator	130.00
520B	—5000 Watt Oscillator and R. F. Power Amplifier—water cooled	250.00
565	—7½ Watt Screen Grid R. F. Amplifier	22.00
560	—75 Watt Screen Grid R. F. Amplifier	50.00
561	—500 Watt Screen Grid R. F. Amplifier	390.00
566	—A half-wave hot cathode, mercury vapor rectifier Medium Current	12.50
572	—A half-wave cathode, mercury vapor rectifier, Heavy Current	30.00

The new De Forest Radiophone Receiver, Type CS5 illustrated above, is designed to receive both telephone and telegraph signals on all frequencies between 1,500 and 15,000 kilocycles (20 to 200 meters).

Being small and light it is excellent for portable work. Its enormous amplification giving loud speaker signals on a 10 ft. antenna.

The special circuit uses four Audions; two Screen Grid Audions as radio frequency amplifier and space-charge-grid detector (power detector) and two Audions in a transformer-coupled audio amplifier. Housed in an aluminum case, 5″ x 6″ x 9″, this receiver, although full-grown in strength and performance, makes an ideal short wave receiver for aircraft reception where light weight is a necessity. It is also adapted for general amateur use, small yachts, police cars and automobiles.

DE FOREST RADIO CO., PASSAIC, N. J.
Branch Offices Located in
Boston, New York, Philadelphia, Atlanta, Pittsburgh, Chicago, Minneapolis, St. Louis, Kansas City, Denver, Los Angeles, Seattle, Detroit, Dallas, Cleveland

de Forest
AUDIONS

Specifications for De Forest Radiophone Receiver Type CS5

Battery Requirements

Operates either from dry cells using Audions 422A and 499 or from 6 volt storage battery using Audions 422 and 401A. For loud speaker operation either Audions 420, 412A or 471B may be inserted in the last audio stage. Two 45 volt "B" batteries furnish the plate power.

Features

Extremely compact and light in weight.
Screen grid R. F. Amplifier.
Space-charge-grid power detector.
Two stages of audio amplification.
Zero body capacity.
Frequency calibration independent of antenna used.
Moisture and climate proof.
Negligible microphonics.

• • • • • • • • • • • USE THIS COUPON • • • • • • • • • • •

S. W. Receiver type CS5 (less tubes) ......$75.00 ☐

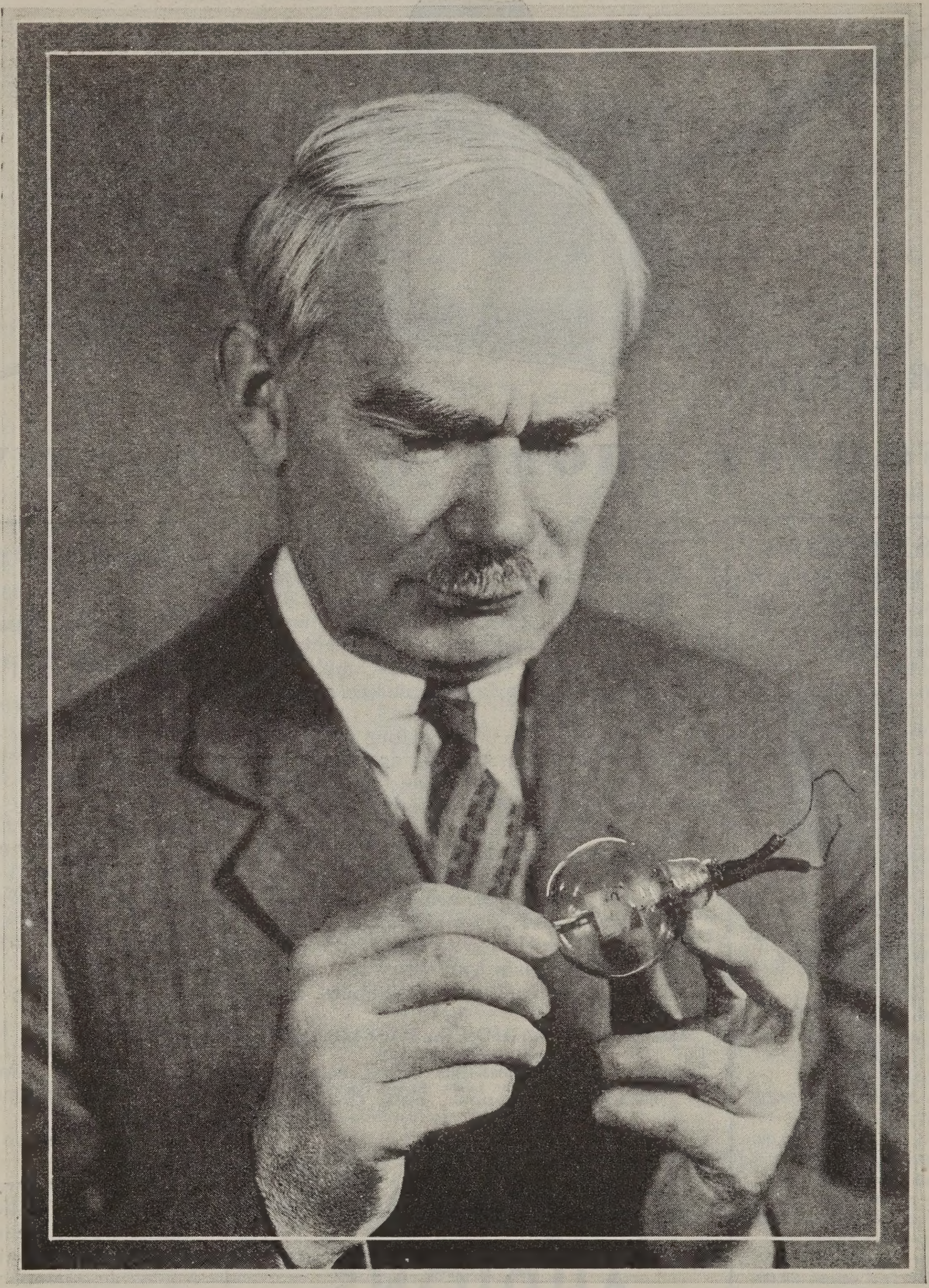
510	$ 9.00	☐	552	32.50	☐
503A	40.00	☐	504A	140.00	☐
511	40.00	☐	500	130.00	☐
545	45.00	☐	520B	250.00	☐
560	50.00	☐	566	12.50	☐
561	390.00	☐	572	30.00	☐
			565	$22.00	☐

DE FOREST RADIO COMPANY,
PASSAIC, NEW JERSEY

Enclosed please find $.......... for which send me the items checked opposite.

Name..

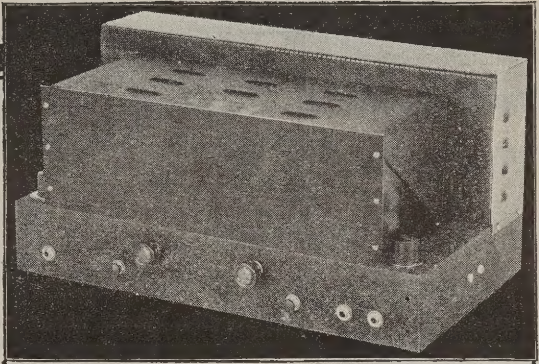
Address..



Dr. Lee de Forest

Inventor of the vacuum tube and directly responsible for the fundamental tube development which makes modern broadcast transmission and reception possible. Dr. de Forest is president of the Institute of Radio Engineers

Look at Its Curve, or Listen to Its Wallop—the 692 Is Unbeatable!



S-M's New Screen-Grid '50 Amplifier

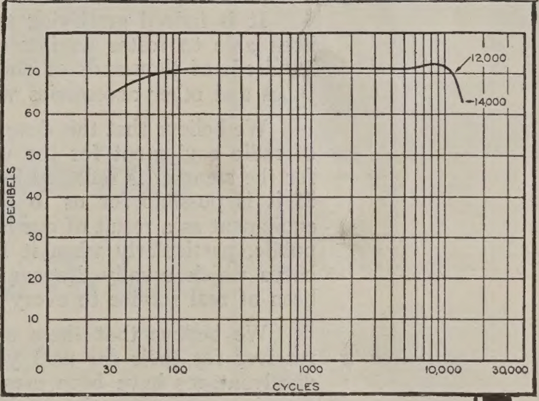
Power, and more power—more gain than you ever imagined could come out of a three-stage amplifier. Tone quality—a flat curve (within 2 DB) from 60 to 12,000 cycles—within 4 DB from 44 to 13,000 cycles. Set one up—try it—and you'll know why we feel so proud of it!

You'll notice the difference in the "highs"—the usual falling-off around 6,000 cycles simply doesn't start till up around 11,000. Voltage amplification totals 4,000—*three times* the usual three-stage total! With proper input transformer there is plenty of gain—as high as 90,000—even for "distant" microphone pickup—or 20,000 from a standard phonograph pickup. High resistance input—operate the 692 out of any source of impedance up to 100,000 ohms. Operate it directly into any speaker system—sixteen combinations give output impedances from 8 to 125 ohms—eliminating any possible distortion in speaker transformer.

Test the 692 just once on your oscillator—and you'll use it thereafter as a standard to test your speakers!

Tubes required: 1—'24, 1—'45, 2—'50, and 2—'81.

Price, completely wired, less tubes, $147, net.



Curve of 692

This curve was not taken at plates of output tubes, but includes output transformer. If input transformer of the speaker is removed, curve shows frequency characteristic as fed direct to speaker.

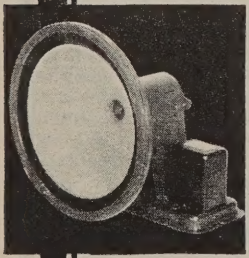
Scour the Air—with an S-M 712

Just the radio tuner you've been looking for as a feed for that power installation. And what a tuner! All-electric, single-dial (no verniers), pre-selector, power detector, battleship shielding cabinet, individually shielded r.f. coils, and all r.f. circuits individually by-passed and isolated—making the 712 absolutely stable and free from oscillation. And it's absolutely guaranteed to out-distance and out-perform all competition regardless of price.

Tubes required: 3—'24, 1—'27. Wired, less tubes, $64.90 net. Parts total $40.90.

The 712 requires separate power supply (2½ volts A, 180 volts B) if used with 692 amplifier. Or S-M 677 amplifier ('45 push-pull, 2-stage) supplies all ABC power required; price, $58.50 net.

S-M Announces New Auditorium Speakers



S-M Auditorium-Type Electro-dynamic Speakers, now offered for the first time, have been designed by engineers associated with the development of the moving-coil speaker ever since its inception. With a curve well-nigh flat from 30 cycles to considerably beyond 8000—able to handle as heavy an input wattage as any speaker on the American market—these net prices are truly surprising:

Type 860: 110v., 60 cycle, with input transformer	$36.00
Type 861: 110v., d. c., with input transformer	29.12
Type 862: same as 860 less input transformer	33.12
Type 863: same as 861 less input transformer	26.20

Comparative curves and detailed information about the new 692 Amplifier were printed in the extra-big issue of the RADIOBUILDER for March 1st. No setbuilder who wishes to be informed about the latest in radio should be without this "mouthpiece of the S-M laboratories". Use the Coupon!

Over 3,000 custom setbuilders, everywhere, operate Authorized S-M Service Stations. Write us about the franchise.

SILVER-MARSHALL, Inc.
6405 West 65th Street Chicago, U. S. A.

Silver-Marshall, Inc.
6405 West 65th Street, Chicago, U. S. A.

____________Please send me, free, the latest S-M Catalog; also sample copy of The Radiobuilder.

For enclosed________________in stamps, send me the following:
______50c Next 12 issues of The Radiobuilder
______$1.00 Next 25 issues of The Radiobuilder

S-M DATA SHEETS as follows, at 2c each:
______No. 3. 730, 731, 732 Short-Wave Sets
______No. 4. 255, 256, etc., Audio Transformers
______No. 6. 740 "Coast-to-Coast" Screen Grid Four
______No. 7. 675ABC High-Voltage Power Supply
______No. 8. 710 Sargent-Rayment Seven
______No. 9. 678PD Phonograph-Radio Amplifier
______No. 12. 669 Power Unit
______No. 14. 722 Band-Selector Seven
______No. 15. 735 Short-Wave "Bearcat"
______No. 16. 712 Tuner (Development from the Sargent-Rayment)
______No. 17. 677 Power Amplifier for use with 712
______No. 18. 772 DC Band-Selector
______No. 19. 692 Amplifier

Name____________________________________

Address__________________________________

Automobile Radio

FOR several months past a great deal of space has been given to the subject of automobile radio receivers in Radio News. In fact, when we began working on this development in a really active sense our efforts were greeted with skepticism and, in some instances, actually repudiated even on the part of members of our own organization. We know, for a fact, that when the General Motors Corporation began the manufacture of automobile radio receivers, certain members of the Board of Directors were opposed to what they considered at the time a fruitless venture.

During the past few months we have communicated with some of the largest manufacturers of radio receivers for automobiles and a complete reversal of opinion has been brought about. Many manufacturers thought that an automobile radio receiver would be an interesting amusement and that it would be possible to sell a few of them to a rather scattered public.

It is indeed gratifying to us to find that within less than a year we have been able to foster an interest in this subject, which at present indicates that hundreds of thousands of dollars worth of radio receivers "B" batteries, vacuum tubes and other accessories will be sold during the coming summer.

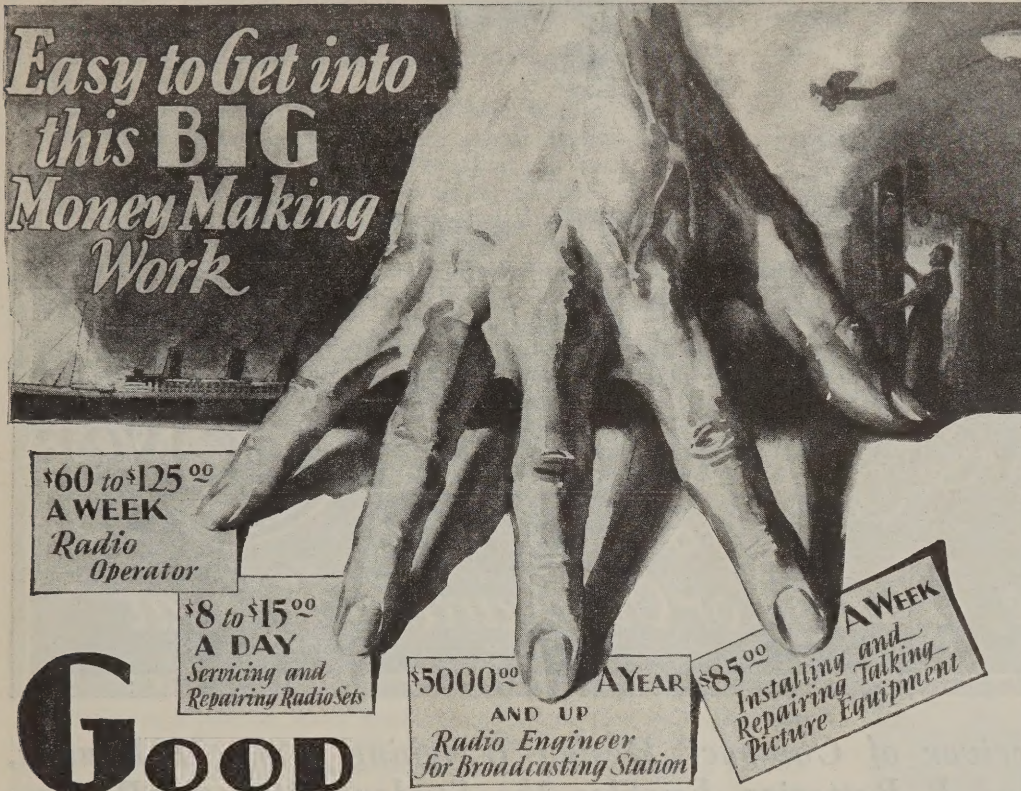
We believe that this development will be of considerable advantage to all users of radio equipment for the very good reason that any improvement in business for the summer is reflected in a lower price for radio equipment to the consumer. If it is possible for us to develop new and extremely large markets for radio equipment as a result of our introducing equipment of this character to the general public, particularly when it is possible by this activity to flatten out the sales curve which usually drops materially during the summer months, we will have been of real service to every radio user.

We believe that there are very few who will want to be without a radio receiver for their car next year. The advantages are exceedingly great and the disadvantages have been greatly magnified by people who have had little or no experience in connection with the use of auto radio receivers. There is no question that for the summer time camping trip or the long night trip between distant cities or even the trip from home to the theatre, which must be made while some particularly interesting program is on the air, will overcome some of the silly objections which have been made to this really satisfactory service.

At present three of the largest radio manufacturing organizations in the country are actively engaged in this business. Within the next month at least half a dozen more will have announced their entry into this field. It is very likely that the sale of radio equipment during the next year will amount to considerably more than a million dollars and it is indeed gratifying to us to know that Radio News is largely responsible for this business.

Arthur H. Lynch

R. T. I. QUALIFIES YOU TO MAKE MONEY AND ITS SERVICE KEEPS YOU UP-TO-THE-MINUTE ON THE NEWEST DEVELOPMENTS IN RADIO, TELEVISION, AND TALKING PICTURES **R. T. I.**


Easy to Get into this BIG Money Making Work
$60 to $125.00 A WEEK Radio Operator
$8 to $15.00 A DAY Servicing and Repairing Radio Sets
$5000.00 A YEAR AND UP Radio Engineer for Broadcasting Station
$85.00 A WEEK Installing and Repairing Talking Picture Equipment

GOOD JOBS *Right at Your Finger Tips* WHEN YOU ARE R.T.I. TRAINED IN RADIO-TELEVISION-*Talking Pictures*

BIG PAY JOBS! SPARE TIME PROFITS! A FINE BUSINESS OF YOUR OWN! They're all open to you and other live wire men who answer the call of RADIO. The fastest growing industry in the world needs more trained men. And now come Television and Talking Movies—the magic sisters of Radio. Will you answer this call? Will you get ready for a big pay job Now and step into a BIGGER ONE later on? You can do it EASILY now.

R. T. I. Home Training Puts You In This Big Money Field

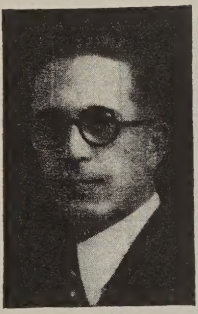
Radio alone, pays over 200 MILLION DOLLARS a year in wages in Broadcasting, Manufacturing, Sales, Service, Commercial Stations and on board the big sea going ships, and many more men are needed. Television and Talking Movies open up other vast fields of money-making opportunities for ambitious men. Get into this great business that is live, new and up-to-date, where thousands of trained men easily earn $60 to $100 a week—where $10,000 a year jobs are plentiful for men with training plus experience.

Easy To Learn At Home—In Spare Time

Learning Radio the R. T. I. way with F. H. Schnell, the "Ace of Radio" behind you is EASY, INTERESTING, really FUN. Only a few spare hours are needed and lack of education or experience won't bother you a bit. We furnish all necessary testing and working apparatus and start you off on practical work you'll enjoy—you learn to do the jobs that pay real money and which are going begging now for want of competent men to fill them.

Amazingly Quick Results

You want to earn BIG MONEY, and you want some of it QUICK. R. T. I. "Three in One" Home Training—Radio-Television-Talking Movies—will give it to you, because it's easy, practical, and is kept right up-to-date with last minute information. In a few weeks you can be doing actual Radio work, making enough EXTRA MONEY to more than pay for your training. In a few short months you can be all through—ready to step into a good paying job or start a business of your own. A BIG JOB—BIG MONEY—A BIG FUTURE. There is no other business in the world like it.



FRED H. SCHNELL
Chief of R. T. I. Staff

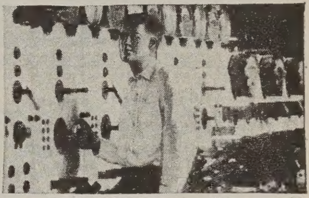
Twenty years of Radio Experience. First to establish two-way amateur communication with Europe. Former Traffic Manager of American Radio Relay League. Lieut. Commander U.S.N.R. Inventor and Designer Radio Apparatus. Consultant Radio Engineer. Now in charge of R. T. I. Radio Training—and you will like his friendly manner of helping you realize your ambition.

Investigate—Send For R. T. I. Book Now

Don't waste a minute. Find out what the great Radio Industry, which has grown faster than the Automobile and Motion Picture business, has to offer you. Find out what other men are earning. SEE HOW EASILY YOU CAN GET STARTED. Get the facts about Radio, Television and the Talking Pictures, first hand, in the big R. T. I. FREE BOOK. Learn what this R. T. I. "Three in One" Home Training can do for you. Mail the Coupon for FREE BOOK NOW.

Radio & Television Institute
Dept. 845
4806 St. Anthony Court, Chicago

R.T.I. Training Brings Big Jobs Like These!



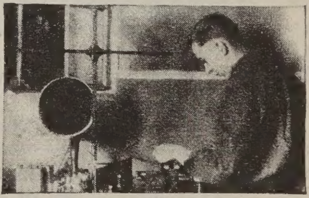
Earned $500 Extra Money in Two Months

Your radio course has enabled me to earn over $500 in two months' spare time work. Understand that this is all spare time work, as I have a permanent position with my father in our store. I give you all the credit for the above and as I said before, I wish to finish the entire course as soon as I can.—Your student, J. NOFFSINGER, Greenville, Ky. R 1, Box 37.

Salary Raised 33 1-3% Since Enrolling

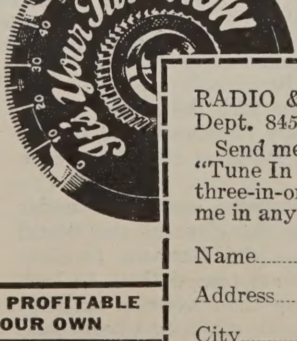
You may be interested to know that I am now Radio Service Manager for the H. N. Knight Supply Co. who are distributors for Eveready Radio Receivers in the State of Oklahoma, and Texas Panhandle, with an increase in salary of about 33 1-3%, since I enrolled with your school.

Thanking you for your interest you have shown in me, and your wonderful course, I am, EARL P. GORDON, 618 East 6th St., Oklahoma City, Okla.



Makes $25 a Day

Haven't forgotten you. How could I when I make as high as $25.00 per day and have made $600.00 in two months from Radio work. That's not so bad when I'm only 19 and in a small town. I just looked over the catalog you sent me before I enrolled, and you did about all you said you would and about as much more.—FLOYD KNISELY, R. F. D. 2, Box 91, St. Joe, Ind.



RADIO & TELEVISION INSTITUTE
Dept. 845, 4806 St. Anthony Court, Chicago

Send me Free and prepaid your BIG BOOK "Tune In On Big Pay" and full details of your three-in-one Home Training (without obligating me in any way).

Name..........

Address..........

City.......... State..........

R. T. I. TRAINS YOU AT HOME FOR A GOOD JOB OR A PROFITABLE PART TIME OR FULL TIME BUSINESS OF YOUR OWN

How to build A Flyweight Portable Receiver for Plane, Glider or Outboard Motorboat

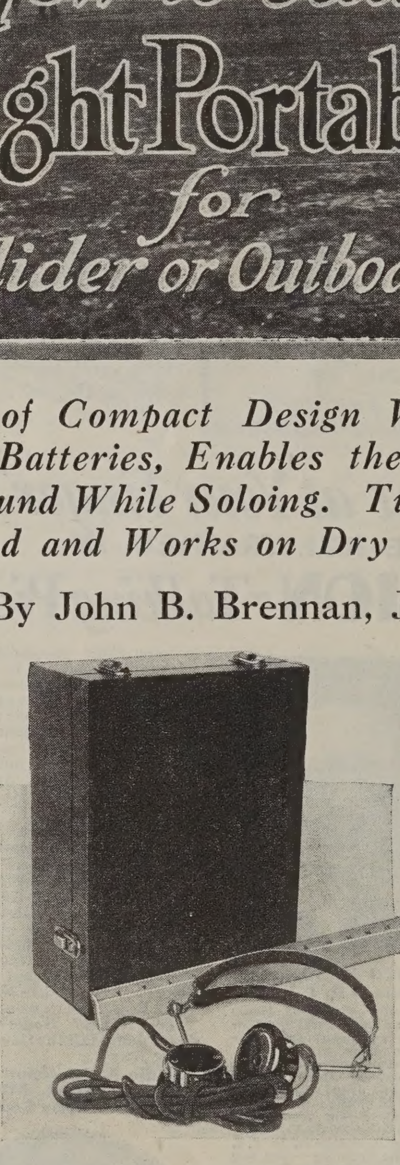
A Three-Tube Receiver of Compact Design Weighing Only 11 Pounds, Including the A and B Batteries, Enables the Student Pilot to Receive Instructions from the Ground While Soloing. Tunes to the 80-Meter Phone Band and Works on Dry Cells

By John B. Brennan, Jr.

UP AND coming Americans have not been slow to recognize the great sport and the opportunities for acquiring a real aeronautical knowledge in the flying of gliders, first seriously taken up by the Germans as a result of restrictions imposed upon them as an outcome of the last war.

Glider Clubs have sprung up virtually overnight in many communities. The movement has rapidly overcome its first growing pains and now it has attained the importance of a real scientific activity by the serious experiments being conducted by hosts of well-known aviation authorities.

Essentially this article concerns radio and how it has been utilized to augment the progress being made in the motorless aviation field. But, to get a clear vision of the whole picture it will be necessary to go back a bit and see what the requirements are which govern glider flying.



An idea of the size of the lightweight three-tube 80-meter receiver, complete with A and B batteries, will be gained from the above illustration

Gliders are the forerunners of our present-day high-powered airplanes. Before it was possible to fly an airplane with the aid of power, it was first necessary to conduct many experiments in the air with the use of outfits which had no motor at all. These were known as gliders.

Activity in the glider field was resumed once more under the leadership of the Germans after the close of the World War. The restrictions imposed upon the Germans to limit the activity in the regular airplane field caused them to look to some other means or an outlet to their aviation activity. It was natural then that the glider work which had been done many years before by such prominent men as Lillienthal and others of German nationality be resumed once more. The movement has grown to such tremendous proportions, that many clubs which have been formed in America have even gone so far as to engage the services of prominent German glider experts to instruct club members in the ways of gliding. Now here's where radio comes into the glider picture.

In operating any one of the three types of gliders, namely, the primary or training ship, the secondary or circling ship, or the advanced or soaring ship, it is necessary to impart some instructions to the student before he takes off. Usually the manner in which this is effected is to give last-minute instructions while the student is seated in the plane prior to his take-off, or to shout instructions to him immediately after he has taken off. In the primary or training type of glider, the elapsed time of flight is not very great, and therefore the instructions which may be shouted to him are only of a momentary nature. As the student progresses and becomes experienced in the handling of the more advanced types of gliders the length of time which he may stay aloft increases, and, it is here where some means of furnishing him with additional instructions, to those which have been given him while on the ground, are of importance.

So that such instructions may be given to the student gliderman the Laboratory of RADIO NEWS has designed a small compact light-weight receiver employing three tubes which may be used in the glider for the reception of telephone

INTEREST in gliders is decidedly on the up-and-up. Countless numbers of glider enthusiasts have banded together, formed glider clubs and have even gone so far as to import foreign tutors to teach them in the ways of motorless plane flying.

To augment the ground instruction, Radio News Laboratory has constructed the small, lightweight three-tube receiver described here, so that the fledgling in the air might receive additional instructions while in flight, from the instructor on the ground, by means of short-wave radio. The receiver, while designed primarily for glider use, is ideally suited, because of its small size and light weight, for use in outboard motorboats and other small water craft.

By use of the glider receiver and a suitable phone transmitter, ground instruction can be augmented by actually directing the student gliderman's gyrations while in flight

Photo © International Newsreel

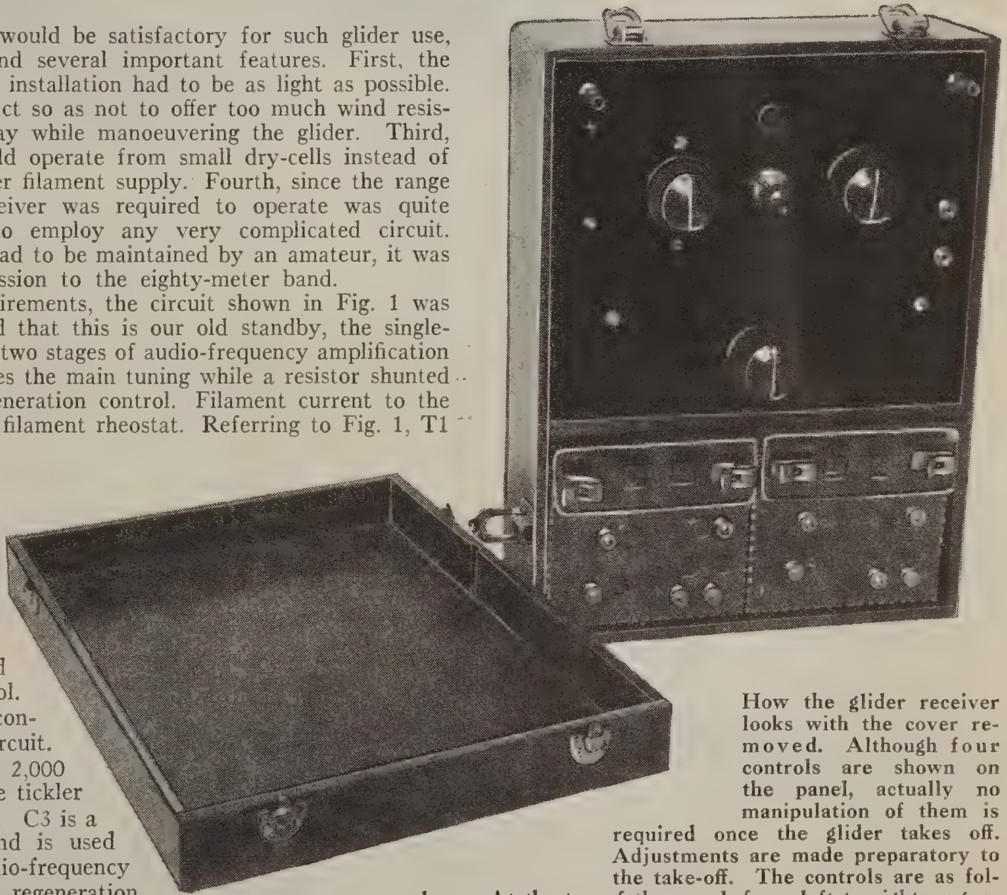
instructions sent out to him by the instructor on the ground.

Under the conditions under which it must operate, the receiver has limited receiving range, but nevertheless tests conducted at Roosevelt Field have indicated, that with a suitable transmitter located at some point on the flying field, signals were satisfactorily picked up for distances somewhat greater than a half-mile, with volume plenty loud enough for intelligently understanding the speech that was spoken into the microphone at the transmitter on the ground.

Receiver Design Features

In designing a receiver which would be satisfactory for such glider use, it was necessary to keep in mind several important features. First, the overall weight of the entire radio installation had to be as light as possible. Second, it had to be quite compact so as not to offer too much wind resistance, or be in the operator's way while manoeuvering the glider. Third, it had to use such tubes as would operate from small dry-cells instead of those which would require a larger filament supply. Fourth, since the range or distance over which the receiver was required to operate was quite limited, it was not necessary to employ any very complicated circuit. Fifth, inasmuch as transmission had to be maintained by an amateur, it was necessary to confine the transmission to the eighty-meter band.

So as to satisfy all these requirements, the circuit shown in Fig. 1 was finally chosen. It will be noticed that this is our old standby, the single-circuit regenerative receiver, with two stages of audio-frequency amplification added thereto. One condenser does the main tuning while a resistor shunted across the tickler provides a regeneration control. Filament current to the tubes is regulated by means of a filament rheostat. Referring to Fig. 1, T1 is the radio-frequency transformer which couples the antenna to the detector tube. It is wound on a piece of tube 1⅛ inches in diameter by 2⅜ inches long. The details for the coil are given in Fig. 2, and will be explained later. The tuning condenser C1 is shunted directly across the secondary and provides the main tuning control. C2 and R2 are used as the grid condenser and leak in the grid circuit. The variable resistor R3 is the 2,000 ohm resistance shunted across the tickler to obtain the regeneration control. C3 is a fixed condenser of .001 mfd. and is used to shunt the primary of the audio-frequency transformer T2 so as to promote regeneration, by providing a return path to ground for the radio-frequency currents which come from the tickler circuit. The two transformers T2 and T3 and the two tubes V2 and V3 make up the two-stage audio-frequency amplifier which outputs to the pair of head-phones.



How the glider receiver looks with the cover removed. Although four controls are shown on the panel, actually no manipulation of them is required once the glider takes off. Adjustments are made preparatory to the take-off. The controls are as follows: At the top of the panel, from left to right: regeneration resistor, filament switch, tuning condenser. Lower center: filament rheostat. At the upper corners are shown the counterpoise and antenna tip-jacks with plugs inserted

Filament supply to the three tubes is provided by the 4½-volt bank of batteries which are of the dry cell type, two of which are connected in parallel to give longer life. The two 22½-volt "B" batteries are connected in series to provide a total of 45 volts to the plates of the two audio tubes. The return side of the primary of the first audio transformer T2 is brought down to a lead which might be called an exploring lead since it is necessary to connect this terminal or lead to various voltage output taps along the two 22½-volt batteries until the most satisfactory value for regeneration is obtained. In some cases it will be found necessary to apply the full 45 volts to the plates of the detector tube so as to obtain a satisfactory regenerative condition. By means of the rheostat R1, the filament voltage is adjusted to the necessary three volts required for lighting the filaments of the tubes.

With the coil (as described and illustrated in Fig. 2) and the small midget condenser employed for tuning, the waveband covered by the tuning circuit varies roughly from 75 to 95 meters. As shown in Fig. 2, the tuning coil is wound on a cylinder 2⅜ inches long by 1⅛ inches in diameter. This coil is supported from the back of the panel by two long flat head machine-screws. The secondary coil, consisting of 45 turns of No. 26 double cotton-covered wire, is wound first. The beginning of the winding is started 7/16ths of an inch in from one end of the coil and continued for 45 turns until completed. The primary coil is wound at the lower end of the secondary and directly over it. Between the two windings is placed a piece of insulating paper or adhesive tape about three-quarters of an inch wide. The primary consists of fifteen turns of the same size wire as used for the secondary, the winding beginning at the edge of the secondary and running forward the requisite number of turns, and then ended. The direction of the winding, it is important to remember, should be in the same direction as the direction of winding for the secondary coil. The figure shows the tickler coil as located inside the tubing upon which is wound the primary and secondary coils. This is not absolutely necessary and, if it is desired, the tickler may be wound directly over the secondary in a similar manner to the primary, the tickler consisting of 45 turns of No. 26 double cotton-covered wire, random wound or bunched together. The more efficient way to wind the tickler is to obtain a piece of tubing smaller in diameter than the inside diameter of the main piece of tubing and then wind on it 45 turns of wire, being careful to wind the coil in the same direction of winding as for the secondary coil. When this tickler coil is completed, it may be slid inside the secondary coil form and fastened there with adhesive tape or some other binder.

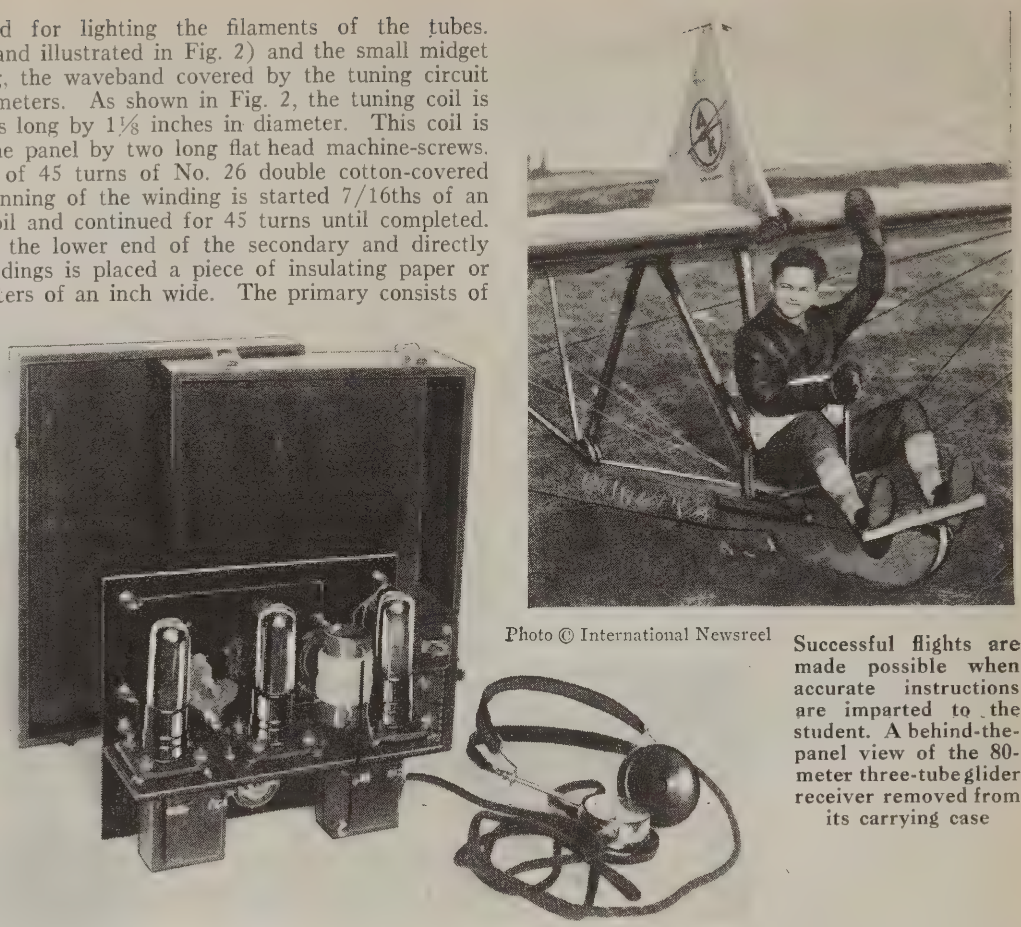


Photo © International Newsreel

Successful flights are made possible when accurate instructions are imparted to the student. A behind-the-panel view of the 80-meter three-tube glider receiver removed from its carrying case

Leads coming from the various coils on the coil forms are numbered and, for correct connection in the circuit, should be compared with the circuit diagram, Fig. 1.

Assembling the Receiver

Details for drilling the main panel and the sub-panel, or the shelf, are given in Fig. 3. The main panel is 7″ tall by 8¼″ wide, while the sub-panel is 8¼″ long by 3$\frac{13}{16}$″ wide. These two pieces of panel should be prepared in accordance with the panel layout referred to above. Once completed, it will be necessary to mount on the panels the various pieces of apparatus such as filament rheostat, variable resistor for regeneration control, tuning condenser, coil assembly, antenna and counterpoise tip-jacks and the telephone tip-jacks. On the shelf are located the three tube sockets and also the two audio-frequency transformers. The tube sockets are mounted on the top side of the shelf, while the transformers are mounted below. Before actually fastening the transformers and tube sockets in place, it would be well to temporarily arrange them and, holding the shelf against the back of the main panel, see whether you obtain enough clearance between tube sockets to allow the proper functioning of the coils and variable tuning condenser. On the under side of the shelf it will be necessary to locate the two transformers at the extreme ends of the shelf, so as to allow enough room in the middle for the location of the filament rheostat, which is mounted directly on the back of the main panel. The photographs accompanying show how the parts were arranged in the receiver built in the Laboratory of RADIO NEWS.

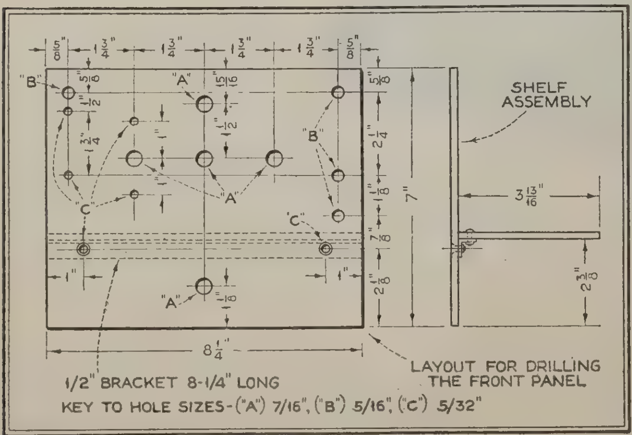


Fig. 3—For drilling the main panel and mounting the shelf to its back, the drilling and assembly details given above should be followed carefully

Once the receiver is assembled, it will be well then to consider the construction of a suitable cabinet for carrying it. Fig. 4 shows the constructional details of such a cabinet. The main compartment is 8¼ inches wide (inside dimensions), 7 inches high and 4 inches deep. The lower compartment, housing the "A" and "B" batteries, is 4 inches high and 8¼ inches long. This compartment, also, is 4 inches deep. A cover, not shown in the photograph or drawing, should also be constructed to fit over the cabinet so as to completely enclose it when not in use, or while it is in use, after the receiver has been adjusted for best reception.

The wiring details for such a simple receiver require nothing more than the circuit, which is outlined in Fig. 1. A stranded, insulated flexible wire should be used to insure against breaking of contacts, due to the jarring the receiver is likely to get while in use. Naturally, it is well to be sure that all of the connections are firmly and securely soldered.

The 80-meter transmitter used by the laboratory in the radio-glider tests is the portable transmitter built by Lieut. Wenstrom, and first described by him in the July, 1929, issue of RADIO NEWS. This transmitter is entirely portable, being operated from a storage battery for filament supply and four heavy-duty "B" batteries for plate supply. A transmitter similar to this one will have ample range for the work in hand.

Preliminary Tests

Once the receiver is completed, it is well to conduct some tests preparatory to its actual use in the glider. To conduct such tests it will be well to install the radio receiver in the glider, locating it on the main strut or lashing it down on the top of the wing. Any location is satisfactory, so long as the receiver is firmly located, so as to prevent it working loose and perhaps dropping. By locating it on the main strut it is possible to have it close enough to the student gliderman's head so as to have extremely short telephone leads from the set to the headphones. Second, by locating it here, it is easily available for quick tuning or other adjustment which may be found necessary. If a portable transmitter such as that referred to above is available, it should be located away from the receiver a distance of about a quarter or a half mile. Then the receiver should be mounted in position on the glider. Secondly, an antenna should be erected across the wing of the glider and connected to the proper binding post on the receiver. Third, the guy wires of the glider can be connected together to form a counterpoise or a separate wire run from the receiver to the tail of the glider to form a counterpoise. After these directions have been followed, the receiver should be turned on and a test conducted between the transmitter and receiver to determine the tuning adjustment of the receiving circuit. Once the signal has been tuned in, the regeneration control should be retarded until speech is intelligently received. Then the cover may be replaced on the receiver box and the student gliderman may take his place in the glider and prepare to ascend. While he is in the air, even though the duration be short, the instructor on the ground at the transmitter may direct the movements of the student gliderman and furnish him with instructions which otherwise would have to be shouted to him under rather unfavorable conditions.

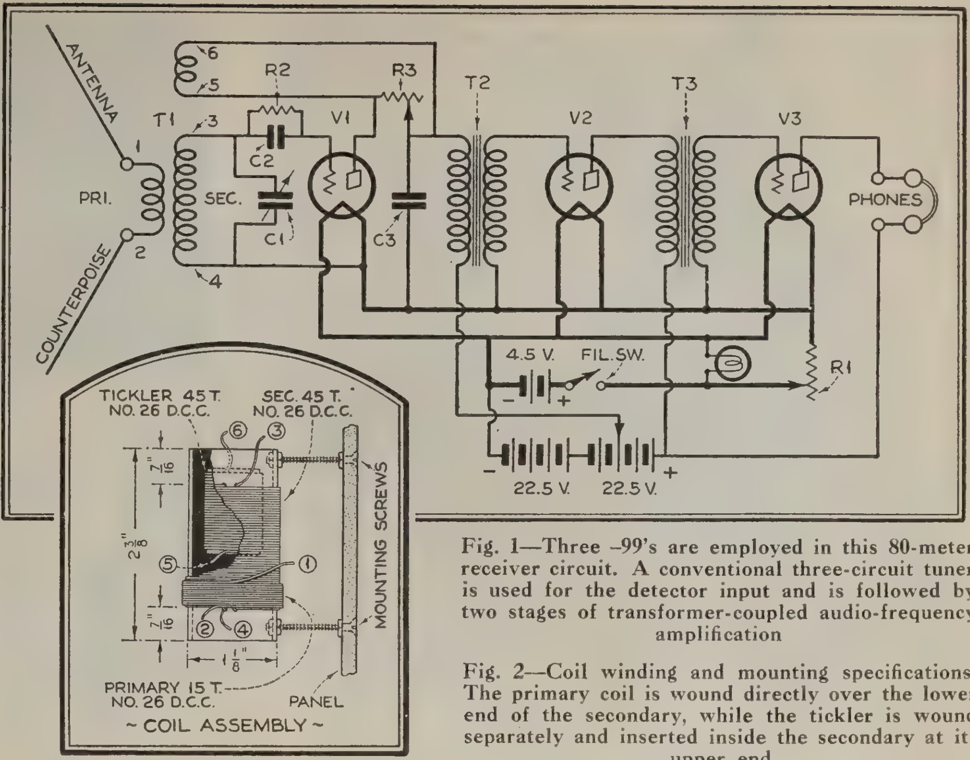


Fig. 1—Three –99's are employed in this 80-meter receiver circuit. A conventional three-circuit tuner is used for the detector input and is followed by two stages of transformer-coupled audio-frequency amplification

Fig. 2—Coil winding and mounting specifications. The primary coil is wound directly over the lower end of the secondary, while the tickler is wound separately and inserted inside the secondary at its upper end

Parts List

C1—Hammarlund midget condenser, 32 mmfd.
T1—80-meter coil (wound as shown in Fig. 2)
C2—Aerovox grid condenser, .00025 mfd.
C3—Aerovox by-pass condenser, .001 mfd.
R1—Yaxley junior rheostat, 20 ohms
R2—Durham metallized grid leak, 3 megs.
R3—Electrad royalty variable resistor, 0-2,000 ohms
T2, T3—Thordarson audio transformers, type R-260
One Yaxley battery switch, No. 10, with pilot light
Four Yaxley pup jacks, No. 416
Two Yaxley pup plugs, No. 415
Three Benjamin spring sockets, No. 9040
One roll Corwico flexibus hook-up wire
One main panel and shelf (see Fig. 3)
One carrying case (see Fig. 4)
Two Eveready 22½-volt "B" batteries (small)
Two Eveready 4½-volt "C" batteries (for filament supply)

In Radio News for June

A complete short-wave call list and time schedule
Practical work for the amateur in correlating radio with sunspots
Full constructional details for an 80-meter phone transmitter and receiver for boat use
Constructional specifications for the "Radio News Cornet Receiver" and other short-wave features

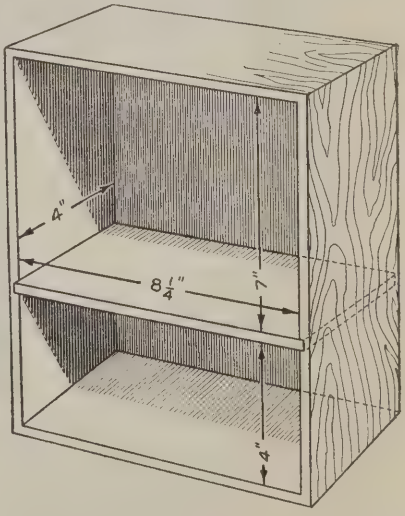
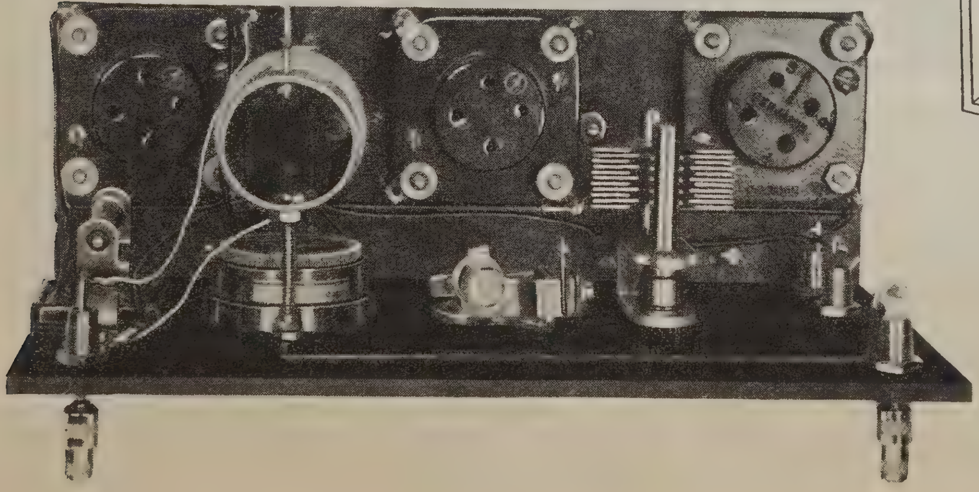
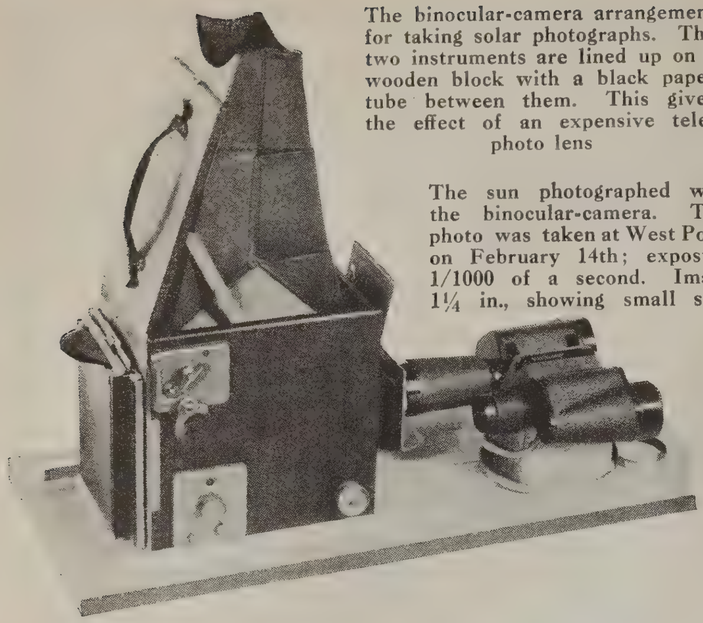


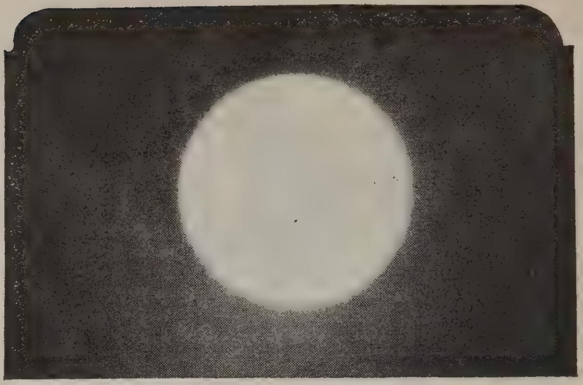
Fig. 4—The carrying case consists of two compartments; the upper one houses the receiver assembly, the lower one accommodates the A and B batteries



Looking over the top of the panel at the shelf assembly. The middle socket is not exactly centered, being shifted to the right slightly to make room for the tuning coil



The binocular-camera arrangement for taking solar photographs. The two instruments are lined up on a wooden block with a black paper tube between them. This gives the effect of an expensive telephoto lens



The sun photographed with the binocular-camera. This photo was taken at West Point on February 14th; exposure 1/1000 of a second. Image 1¼ in., showing small spot

Tying Up Radio with

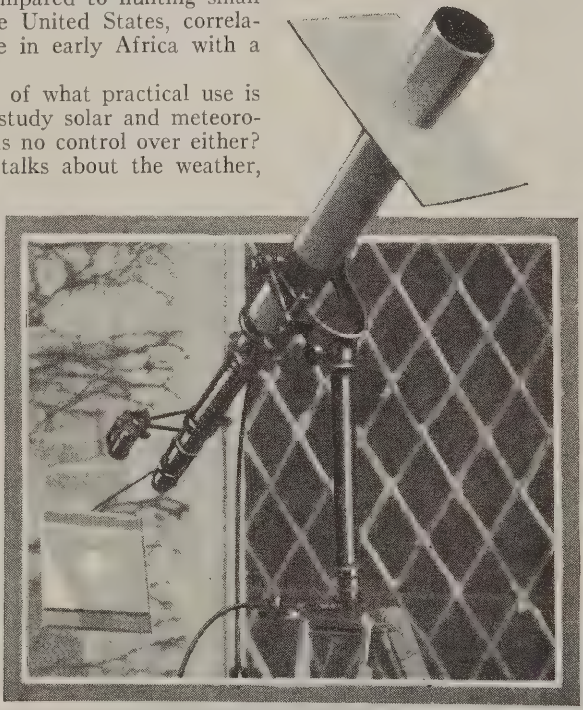
By
Lieut. Wm. H. Wenstrom

SUNSPOTS, weather and radio and their effects, one upon the other, furnish a promising field of investigation for the amateur. For one thing this correlation work is comparatively new and uncrowded; there is scant possibility of repeating here what thousands have already done. In addition, the various phenomena are but vaguely understood even by the foremost scientists, so that the investigator is continually verging on the unknown. While operating a transmitter might be compared to hunting small game under strict regulations in the United States, correlation work is like being turned loose in early Africa with a flintlock musket.

To many will occur the question: of what practical use is all this correlation—why bother to study solar and meteorological effects on radio when man has no control over either? So Mark Twain said: "Everybody talks about the weather, but nobody does anything about it." Still, few people would wish to abolish the United States Weather Bureau and its daily forecasts, increasingly vital to human comfort and safety in the development of aviation.

Similarly, it may some time be possible to issue forecasts of radio transmission. These would be a boon to the two-way amateur, whose narrow bands, crowded with the signals of all nations and often swamped by high-powered interference, offer an uncertain channel at best for long-distance work with low power. Now foreign contacts mean long night hours at the key, perhaps when conditions are such that there is not the slightest chance of getting through. It may eventually be possible for the amateur to receive transmission forecasts and catch up on sleep when the conditions are unfavorable. Then, as shown in the photograph, he may set his alarm clock when a good night is predicted and get up in the small hours reasonably certain of working the antipodes.

Eventually, too, broadcasting stations may vary their power with the actual transmission conditions, so that weak signals on poor nights and heterodynes on good nights will alike be eliminated. Aside from any practical value it may have, correlation work is interesting and new to some of us, because it promises to teach us a little more about the nature of the physical world in which man lives—to advance us a step further on the long climb from the slough of the beast to our distant and unknown goal.



Projecting the sun's image with a small telescope. The 60 mm. refractor, adjusted to give an image about two inches in diameter

It is probable that most of the advances in this terra nova will be made by outstanding scientists and engineers—not because they are famous but because through years of hard work they have attained the knowledge and the intellect necessary in such investigations. But anyone will find it interesting to observe the sun, to note the weather, and to keep some sort of record of radio reception, forming his own opinions of causes and effects. So long as these opinions are not too seriously regarded, the activity will be pleasant, and the results worth while for the individual at least. The more serious investigator (and amateurs of this type are among the great names of science) should have a broad background of theoretical and practical knowledge. Familiar with the simpler methods of mathematics, he should take observations accurately and relate them in their due proportion. The bibliographies of this article and last month's article ("Sunspots, Weather and Radio," RADIO NEWS, April, 1930) indicate some essential reading, much of it far from easy.

But the attitude of the scientific mind is probably more important than its knowledge. In outlining this viewpoint we can do no better than quote from Huxley's splendid essay, "On the Method of Scientific Investigation," which applies equally to sunspot observations, radio measurements, or any other work one may undertake:

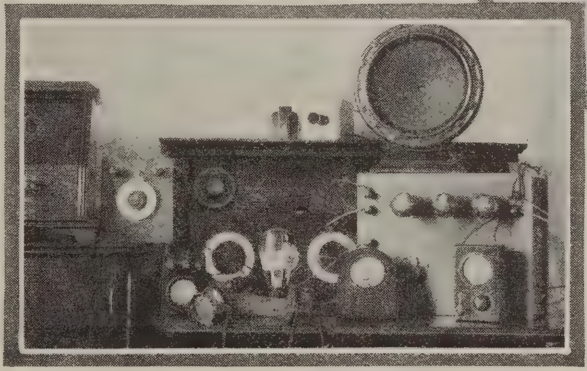
The sun as it appears through an eight-power field glass. The larger spots can be clearly seen. Some protective device must be used to cut down the light

Looking at the sun with ordinary binoculars. The eye is protected from excessive light by the over-exposed photographic film held in front of the objective

Sunspots

The Amateur, with Only Limited Facilities, Is Afforded a Great Research Opportunity to Do Some Practical Work in Relating Sunspots, Weather and Radio

Will it ever be possible for an amateur to get up on a given morning certain of working Australia? When solar and weather effects on radio are better understood, radio forecasting may become possible



Apparatus for measuring the strength of radio signals from a distant station (to the left)

> "Wherever there are complex masses of phenomena to be inquired into, whether they be phenomena of the affairs of daily life, or whether they belong to the more abstruse and difficult problems laid before the philosopher, our course of proceeding in unraveling that complex chain of phenomena with a view to get at its cause, is always the same; in all cases we must invent an hypotheses; we must place before ourselves some more or less likely supposition respecting that cause; and then, having assumed an hypothesis, having supposed a cause for the phenomena in question, we must endeavor, on the one hand, to demonstrate our hypotheses, or, on the other, to upset and reject it altogether, by testing it in three ways. We must, in the first place, be prepared to prove that the supposed causes of the phenomena exist in nature; that they are what the logicians call veræ causæ—true causes; in the next place, we should be prepared to show that the assumed causes of the phenomena are competent to produce such as those we wish to explain by them; and in the last place, we ought to be able to show that no other known causes are competent to produce these phenomena. If we can succeed in satisfying these three conditions, we shall have demonstrated our hypotheses; or rather I ought to say, we shall have proved it as far as certainty is possible for us; for, after five all there is no one of our surest convictions which may not be upset, or at any rate modified by a further accession of knowledge. . . ."

Observing the Sun

As we stated last month, the most readily observed indication of solar activity is sunspots. When these great solar vortices are very large, as they were in November and December, 1929, they can be seen with the naked eye if the sun is behind mist or clouds, or if the eye is protected by smoked glass. Better than smoked glass is a layer or two of over-exposed kodak film, because it transmits all the colors about equally while the smoked glass gives the sun a reddish or coppery tinge. Opera glasses behind the negative will enlarge the image and bring smaller spots into view, while with a six- or eight-power field glass (preferably a good make of prism binocular) average spots can be easily seen. Six power is the highest ordinarily suitable for a hand glass, but eight power shows more detail with a tripod mount or a good head-and-elbow rest to minimize vibration. Some binoculars, such as the Zeiss 8 x 40 mm. used by the writer, have sun filter, or little dark glasses that slip over the eye-pieces, as optional equipment. But the large prism binoculars are quite expensive, and for solar work the cheaper Galilean type field glass, which focuses the image directly upon the retina of the eye, is entirely satisfactory. The disadvantages of the Galilean glass are: somewhat more critical focusing and a much narrower field of view. Large objectives are important even in solar work where the light is

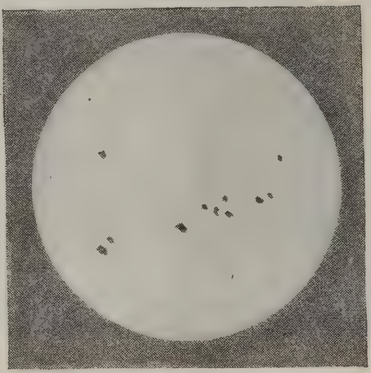
The five-inch reflecting telescope. This telescope, mounted in a revolving dome, was used by the writer in solar observations

excessive, for in addition to gathering more light, they give clearer definition. A good pair of glasses is worth having for many reasons; they can be turned not only on the sun, but on the planets and stars, not to mention all the views of the world.

For more serious solar work a small telescope, of good make and tripod mounted, is useful. They are expensive—the Zeiss 60 mm. astronomical telescope which appears in the photographs costs nearly as much as a Ford. The eye-pieces go up to 94 power, but 47x is the highest one which will include the whole solar disk. With it sunspots, large and small, are clearly visible, and the larger one show a black umbra surrounded by a brownish penumbra. The faculæ—bright, irregular clouds which seem to cluster around large spot groups—stand out clearly also when they are near the sun's edges. These faculæ may be a factor, even more important than the spots, in the depression of night radio reception.

Checking Sunspots

One of the common solar observations in correlation work is the spot area or number for the day. In Wolf's formula: Wolf number = constant × [10x (number of groups and isolated spots) + total number of spots in and out of groups] the Wolf number gives a fair relative approximation of total spotted area of about 2,000 millionths of the sun's surface. Wolf took the constant as unity for himself with a 3-inch telescope and a magnification of 64x. Theoretically the Wolf constant is about 1.3 for the 60 mm. telescope and slightly more than 2 for the 40 mm. binoculars. Actual observations here at West Point have shown these values to hold good in practice with reasonable accuracy. For 6x binoculars the value of the constant would probably run above 3; and of course with the smaller glasses the accuracy falls off rapidly. Over a span of years high sunspot numbers mean much variation in the earth's magnetic field, many auroræ, good day radio reception, poor night reception, and usually more rainfall and slightly cooler weather over the whole earth. Thus radio reception during the last two or three years has been below normal—particularly so in April 1926, April-May-June, 1928, and November-December, 1929. This was due to the peculiar shape of the sunspot curve during the present cycle; the maximum extends through a longer time than usual, and shows three distinct peaks instead of one. Perhaps the center peak in the summer of 1928 represents the eleven-year maximum, while the earlier and later peaks show, respectively, the 25-month and 15-month cycles superimposed on the larger one.



The solar image as projected by the five-inch reflector. This photo shows the enormous spot stream of November 30, 1929, 700,000 miles long—the largest in 33 years

THE next issue of Radio News will be a *short-wave number*. Some of the features it will contain are: A complete short-wave broadcast call list and time schedule, the design details of two short-wave broadcast and code receivers, a constructional article on an 80-meter transmitter and receiver especially designed for small boat use, and another illuminating article from the pen of Lieut. Wm. H. Wenstrom.

In day-to-day correlation work sunspot numbers assume a minor rôle, and the important thing is spot positions. In plotting these latter the main thing is to note when a large spot or group crosses the center of the disk, making a so-called "meridian passage" and pointing generally earthward if its latitude is favorable. The difficulty here is that, due to the earth's motion, we never get a fair view of the sun with its equator appearing exactly horizontal. In December the north pole apparently tips slightly to the left, in March it tips away from us; in June it tips to the right; and in September it tips toward us. But as this apparent annual tipping is limited to 7¼ degrees, it is not very important in approximate observations. The daily tipping is much more noticeable. Compared with the horizon in our latitudes, the rising sun appears to be tipped about 45 degrees to the left, while at sunset it seems to tip an equal amount to the right. Any hour of the day finds it in a proportional midway position.

As explained last month, due to the sun's rotation the spots appear to drift across the disk, coming on the east edge, passing center in five or six days, and disappearing on the west edge in five or six days more. The east edge is the left one and the west edge the right one—just the opposite of our familiar directions on earthly maps. It is regretted that one of our solar photographs in last month's article was wrongly labeled in this regard. Most spots occur in

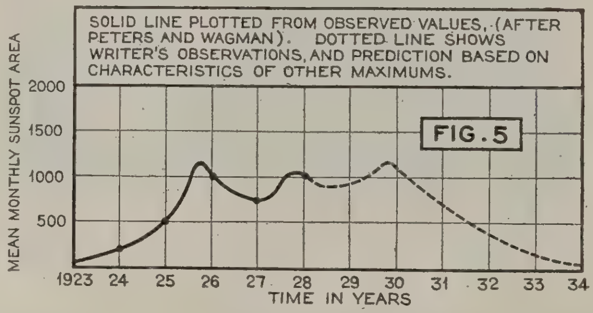


Fig. 5—Why radio reception should improve during the next few years. This graph, plotted partly from measurements made at the U. S. Naval Observatory, shows the peculiar three-hump formation of the recent maximum, and the tapering off to be expected

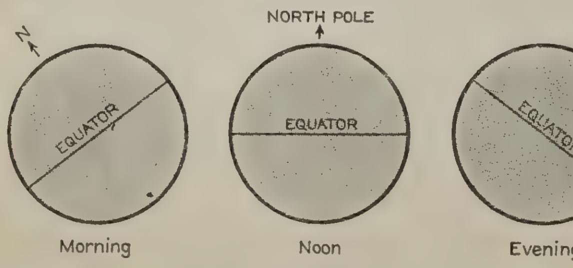


FIG. 1 ~APPARENT TIPPING OF THE SUN THROUGH A DAY~

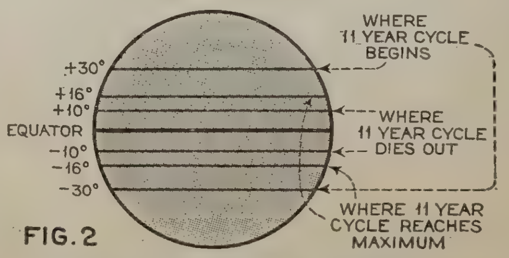
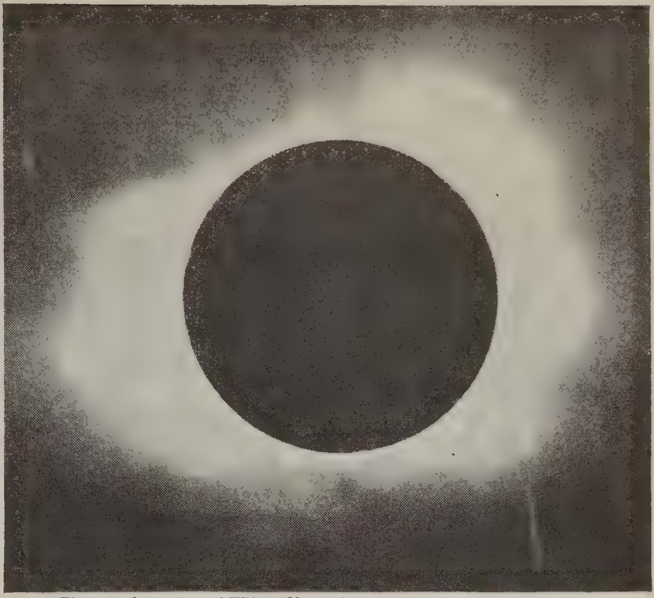

WHERE 11 YEAR CYCLE BEGINS
+30°
+16°
+10°
EQUATOR
−10°
−16°
−30°
WHERE 11 YEAR CYCLE DIES OUT
WHERE 11 YEAR CYCLE REACHES MAXIMUM

FIG. 2 ~EQUATORWARD DRIFT OF SUNSPOT ACTIVITY DURING A CYCLE~

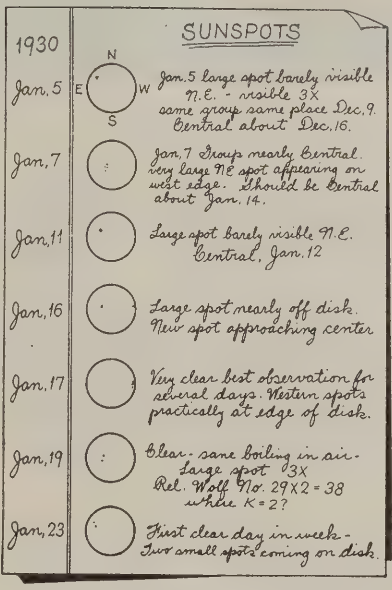
STUDYING the various and little-understood relations of sunspots, weather, changes in the earth's magnetic field, auroræ and radio reception is interesting to anyone with normal curiosity about the physical world and its events. The observation methods described in this article and the following one are so simple that anyone can understand and follow them for his own pleasure and information. In addition, there is a real opportunity for a few serious amateur scientists in this field—at present it is probably the least crowded one in the whole realm of radio. In this article the writer has dealt mainly with the sun and its disturbances, because directly or indirectly the sun is the ultimate cause of all variations in radio reception.



Photograph courtesy of Wilson Observatory

Photograph of a total eclipse of the sun. Taken one year after a sunspot maximum. The corona streams out in all directions, but the polar tufts are suggestive of iron filings about a bar magnet. Several great prominences appear outside the edge of the moon

belts fairly near the equator; the northern spots between 10° and 30° north latitude and the southern ones between similar south latitudes. Usually there are more spots in the southern belt, but during the recent maximum the northern belt has been more active. Spot activity approaches the equator as the 11.4 year cycle wears on. At maximum most of the spots occur in about latitudes 16° north and south. As one cycle dies out around ± 10°, another is beginning around ± 30°. The spots have some motion of their own along the sun's sursurface, but this is usually small in comparison with the sun's rotation.



1930

SUNSPOTS

Jan. 5 — Jan. 5 large spot barely visible N.E. - visible 3X same group same place Dec. 9. Central about Dec. 16.

Jan. 7 — Jan. 7 Group nearly Central. very large NE spot appearing on west edge. Should be Central about Jan. 14.

Jan. 11 — Large spot barely visible N.E. Central, Jan. 12

Jan. 16 — Large spot nearly off disk. New spot approaching center

Jan. 17 — Very clear best observation for several days. Western spots practically at edge of disk.

Jan. 19 — Clear - sane boiling in air - Large spot 3X Rel. Wolf No. 29X2 = 38 where K = 2?

Jan. 23 — First clear day in week - Two small spots coming on disk.

How to keep a simple sunspot record. The writer's record of sunspot positions and sizes as observed with binoculars from January 5 to January 23, 1930

The larger groups may persist through several rotations. The enormous stream of November 30, 1929, showed the largest spotted area in thirty-three years—about 1/200 of the entire visible surface was affected. This group was again central on December 26th, and was still visible, though beginning to break up on January 20, 1930. Similarly the great group of December 16th, which may have influenced the world's weather on December 18th and 19th, returned on January 12th and was checked across the meridian a third time by our observations on February 8th. It is significant here that, in a letter to the writer, Dr. Pickard reported radio signals as abnormally low about November 30th and again about December 16th.

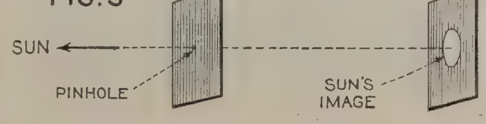
The meridian passage of a large spot or group often appears to generate a magnetic storm or violent fluctuations in the earth's field. According to the records of the U. C. Coast and Geodetic Survey, the group of December 16th caused a mild magnetic disturbance on the same day, but the group of December 26th caused none. Similarly an aurora often seems to follow the meridian passage of a group by one or two days, as if some delaying factor operated in its case. On January 18th a group crossed center and on the 19th an aurora was noted by Yerkes Observatory. The January 27th group seems to be linked with an aurora on the 29th.

The variation of radio reception over the 11.4 year and 15-month sunspot cycles is now fairly well established. In addition the meridian passage of a group usually depresses night reception and enhances day reception, at least in the broadcast band. But the effects are not well timed with what we see as the cause: they may be a day or two ahead or a day or two behind. Perhaps the real cause is something on the sun, such as the ultraviolet flare assumed by Maris and Hulburt, which occurs near but not in sunspot groups.

A simple method of keeping records of solar observations is to draw quarter-size circles down the side of a page, filling in dates, relative sunspot numbers and other data as observations are made. After a little practice the spots can be drawn in fairly accurately freehand after looking through the glasses and fixing their positions and size in the memory. A better way of doing the thing, however, is to project the sun's image on a paper screen with a small telescope and to block in the circle and spots with a pencil just as they appear. One barrel of eight-power field glasses will project a two-inch image within two feet of the eye-piece, and even a 3x opera-glass will give a one-inch image at 2½ feet. In general, the larger objective gives the clearer image and the higher-powered eye-piece gives the larger image in less distance. One of the photographs show the great spot group of November 30th projected with a five-inch reflecting telescope used by the writer.

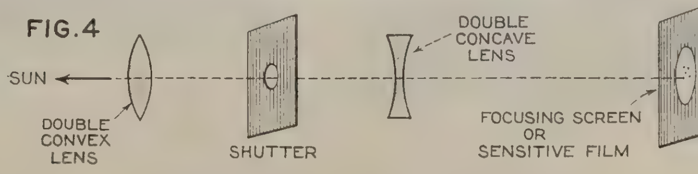
The next logical step is to project the image on photographic film or sensitized paper, making an (*Continued on page* 1036)

FIG. 3



~PROJECTING THE SUN'S IMAGE WITH A PINHOLE~

FIG. 4



~ ESSENTIALS OF A SOLAR CAMERA~

A Sea-Going Radiophone

Boat Owners Will Be Interested in This Inexpensive Limited-Range Short-Wave Telephone Which Utilizes the Same Tubes for Both Transmitting and Receiving. No Government Code Test Is Required for an Operator's License

GONE are the days when tugs, either seagoing or harbor, towing barges or docking liners, have to depend upon signal whistles for receiving their orders, or pleasure craft be entirely isolated from land while under way. The development of the "trans-receiver" has provided a rapid and accurate means of voice communication over short distances.

The conservative range of the apparatus shown is about two miles although it has been operated satisfactorily over a distance of eleven miles. This was considered ample and cut the interference factor to such a low point as to allow it to be considered negligible. Nine of these little sets have been in use for a year on tugboats and barges and have rendered invaluable aid to long tows, not to mention the assistance given to several barges that have broken loose and gone ashore.

When in the receiving position the circuit, shown in Fig. 4 takes the form of a regenerative detector followed by two stages of transformer-coupled audio amplification. In the "transmit" position the last audio tube is idle and the first audio stage acts as a modulator of the detector which then functions as the oscillator. A fixed condenser shunted by a small locking variable tunes the Hartley circuit to the assigned frequency. Another variable condenser is cut in on the sending side to compensate for the difference in capacity due to wiring. A red light indicates when the equipment is in operation, either sending or receiving. Three wires con-

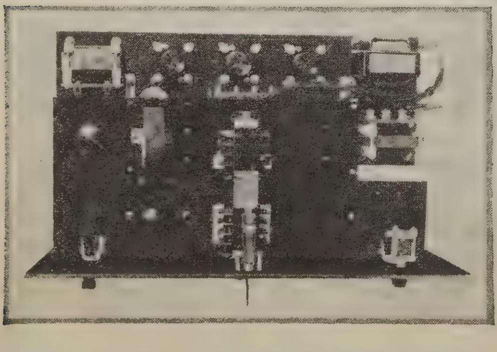


Fig. 1—The top side of the transmitter-receiver. The throw-over switch in the direct center of the sub-panel is the only main control

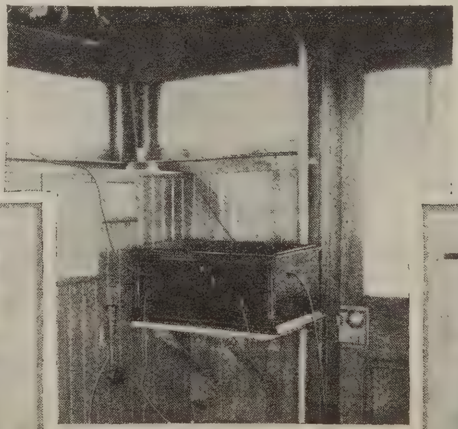


Fig. 2—The transmitter-receiver located in the pilot house of a tug is available for immediate communication purposes. The flip switch in the center of the panel changes the circuit from "receive" to "transmit"

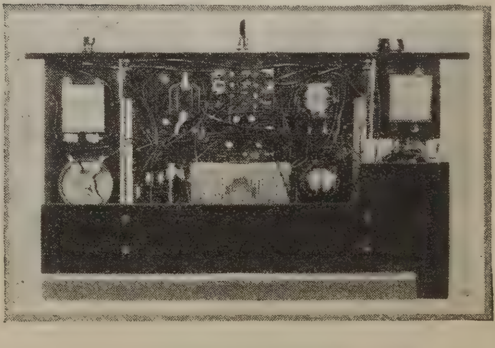


Fig. 3—A view of the under side of the combination unit. The 7.5 volt C battery is actually a part of the assembly

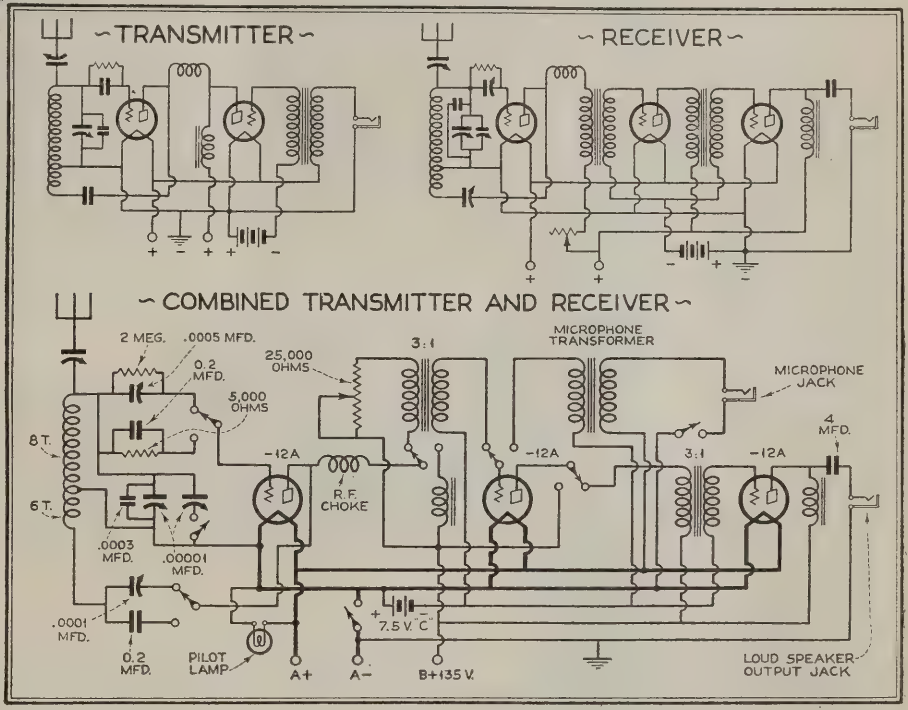


Fig. 4—Above is shown a fundamental circuit of the transmitter and a fundamental of the receiver, while directly below these two is the combined transmitter-receiver circuit

By
William Jones

nected to a polarity plug run from the set to the A and B batteries which are located in any convenient place, while the C battery is mounted on the bottom of the sub-base as shown in Fig. 3. All of the tubes are of the -12A type and the scale indicates the size of the apparatus.

Standard parts were used throughout and a complete unit should not cost more than $75.00. The microphone used is a close-speaking type as used by the U. S. Army air service and was purchased at a salvage supply house, as was the two four-pole, double-throw switches ganged to a common control. The relative positions of the parts may be seen in the top view, Fig. 1.

The nature of the circuit precludes the need of any knowledge of radio for its operation, and makes it impossible to operate two sets if they are not on their assigned frequency. This is due to the fact that there are no exposed frequency controls. The only accessible control is the one which cuts the circuit from the "receive" to the "transmit" position. This makes it capable of operation by the captain of the tug, barge, or steamer.

It is entirely battery-operated and utilizes the same tubes and circuit for receiving and transmitting. This not only simplifies and lowers the construction cost but it also makes impossible to use the equipment unless both stations are on the same frequency. If the transmitted signal is picked up by another set in the receive position it is impossible to answer on any other frequency but the one used for receiving. The tuned circuit of the transmitter is also the tuned circuit of the receiver. The equipment illustrated was operated on *2452* kilocycles—*122.29* meters.

Maintenance cost is practically nothing and the power consumption is surprisingly low. In the receiving or "standby" position the plate current drain is only 10 milliamperes while in the transmitting potion it is 40 mils. A set of heavy duty B batteries will last about eight months. A six-volt storage battery is used for filament supply and is kept charged by a constant one ampere trickle-charge supplied by the tug's generator through a suitable resistance.

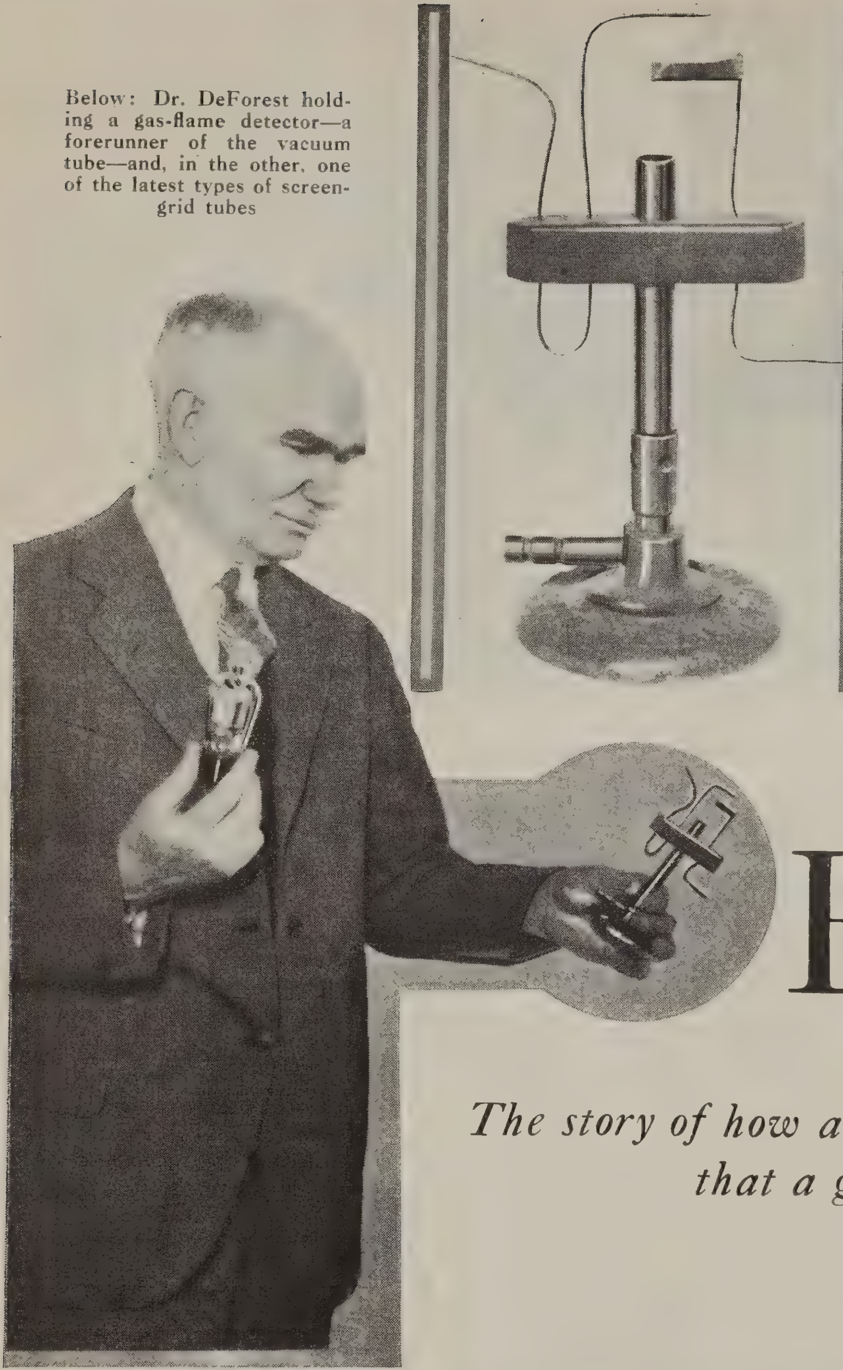
The antenna used by the author was a single strand of copper wire 30 feet long which led directly upwards to a point on the mast of the tug. On the barge it was more nearly in a horizontal plane but equally as efficient.

So much trouble was encountered in the form of crew members making changes and fancied improvements that the set box was locked and the key left in charge of the captain. Another difficulty that had to be overcome which presented more of a problem than we anticipated was teaching the captains to manipulate their barges to the tune of a vocabulary that was emphatic without being profane.

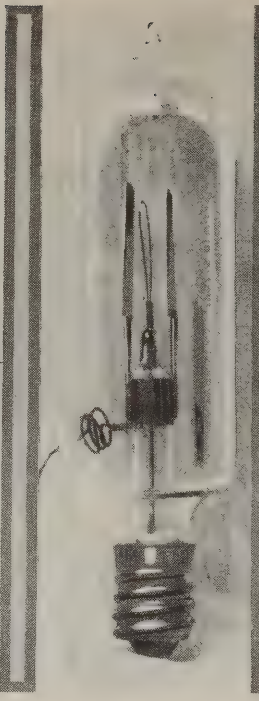
Of course this apparatus has many (*Continued on page* 1036)

Excerpt from Government Regulations Governing the Issuance of Radio Operators' Licenses

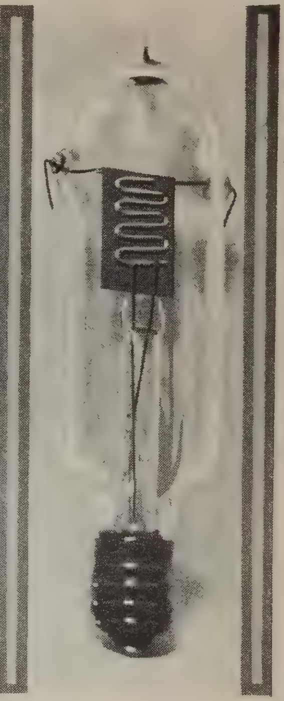
Radiotelephone Class.—No code test is required for this class of license. The particular and theoretical examination for this class shall consist of questions on adjustment and operation of radiotelephone apparatus and knowledge of international regulations governing radio communication and the United States Radio Laws and Regulations. The applicant must demonstrate his ability to transmit and receive clearly conversation by telephone apparatus. Whenever possible, a demonstration of the applicant's ability to operate radiotelephone apparatus will be required. A percentage of 75 will constitute a passing mark. Holders of this class of license are authorized to act as operator only at licensed radiotelephone stations, other than broadcast or amateur, of 300 watts or less input power.



Below: Dr. DeForest holding a gas-flame detector—a forerunner of the vacuum tube—and, in the other, one of the latest types of screen-grid tubes



First vacuum tube detector with a control element in the form of a plate



The first vacuum tube with the control element in the form of a grid

Evolution

The story of how a giant industry has grown that a gas mantle would act as a

By Dr. Lee

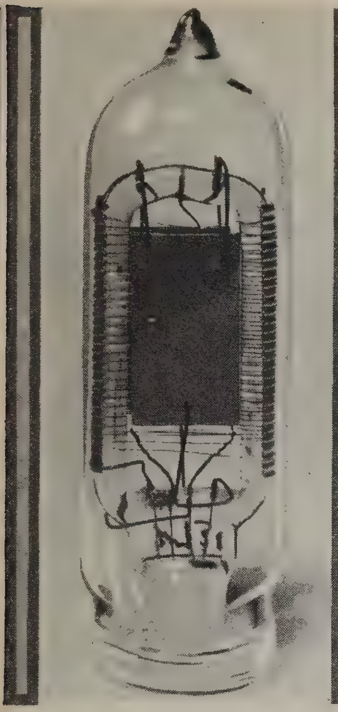
WITHOUT the audion, or three-element vacuum tube, it is unlikely that there would be a radio industry. At least, the radio industry would not be catering to the public at large, supplying millions of radio sets and tens of millions of radio tubes each year, and maintaining over six hundred broadcasting stations, pouring forth a steady stream of entertainment and enlightenment—and considerable advertising. Rather, there would be a relatively small communication business for the handling of marine and transoceanic traffic. In the final analysis, it is the three-element tube that has brought about simplified and practical radio. Hence, in the production of radio tubes—the veritable footlights of the world's stage—is reflected the rapid progress of the radio art, science and industry.

The giant radio tube industry of today came about through an accident. Many readers may recall the story. However, for the newer members of the radio fraternity, I may be permitted to repeat the brief details.

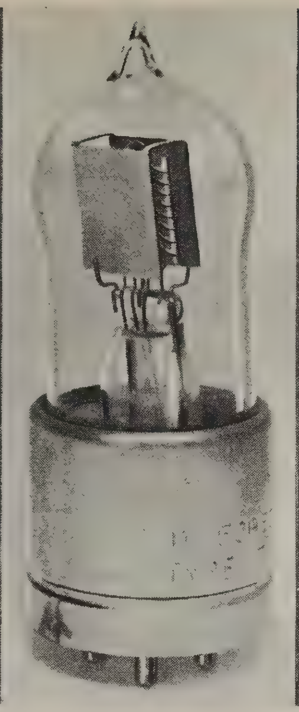
Back in 1904, while engaged as Associate Editor of *The Western Electrician*, I spent my spare time in wireless experiments. Among my possessions was a large spark coil. One evening I noticed that each time the spark jumped the gap, the nearby Welsbach mantle would flicker. It occurred to me that the Hertzian or wireless waves must have some influence on the particles of heated gas in the Welsbach mantle. Perhaps, after all, this might be the basis for a new wireless detector, which was sorely needed.

The first gaseous detector took the form of a standard bunsen burner, with a trough-like electrode containing common table salt and a piece of platinum wire above it, placed in the blue flame of the burner. A battery and receiver were shunted across the flame, through the electrodes. The salt was used to improve the action. The antenna and ground were connected to the two electrodes. Fair results were obtained from this detector.

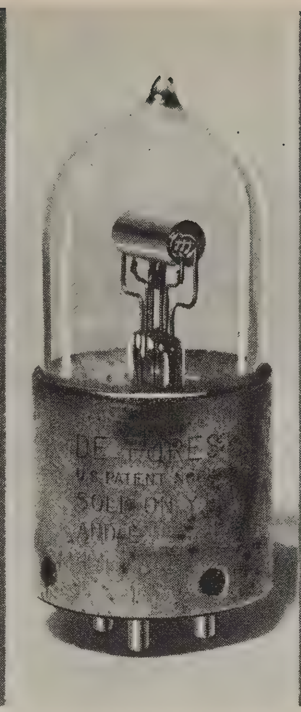
However, marine wireless was our main consideration in those days. And since there was no illuminating gas available on shipboard, I decided to use a glass bulb filled with gas, and a heated filament as the source of heat, operated entirely by batteries. One discovery led to another. The fact that much of the signal energy passed through the battery and head-phone instead of through the gaseous medium, led to the idea of a separate and distinct path for the wireless signal, and in turn the third element made its appearance, first as a metal band around the outside of the glass bulb, then as a second plate quite close to the first or real plate, and finally in the shape of



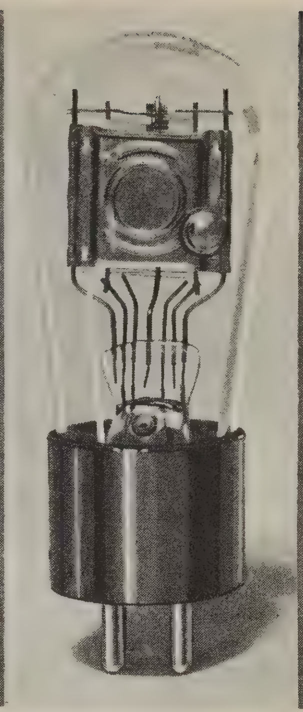
An improved audion with the first grid completely surrounding the filament



An audion used by the Navy. This tube had the first welded grid



Storage battery tube similar in general characteristics to present design



A three-element tube using high-output long-life oxide-coated filament

of the Vacuum Tube

from the accidental discovery
detector of radio waves

De Forest

a zigzag length of wire which, for want of a better name, I called the grid. So by 1906 I had developed the audion or three-element tube, in all respects similar to the standard radio tube of today.

The next step was to manufacture the audion. At first I tried to interest the large lamp companies, since the audion was very much in their line, being a modified electric lamp. But to no avail. The lamp companies had no time to bother with this fantastic experiment. Somewhat of a contrast, to be sure, with present-day conditions when so many lamp companies have rushed into the vacuum tube business because of the greater profits therein.

Finally, I succeeded in interesting one McCandless, a producer of miniature electric lights, located on Park Place in New York City. His plant became the first vacuum tube factory. His men, skilled glassblowers, made the early audions, which were sold mainly to wireless experimenters, for use as a detector. The audion was supplied with a wooden cabinet containing the flashlight batteries for the B circuit, and with binding posts and switches for the necessary connections. According to one of our early advertisements: "The audion detector is operated by heated gases, employs a local battery and is complete with switches, batteries, rheostat and necessary connections. It is fully protected by U. S. Patents Nos. 879,532, 979,275 and others granted to Dr. Lee DeForest and held by the Radio Telephone Company. It is pronounced by experts to be the very best detector obtainable anywhere. Renewal audion bulbs may be secured, in exchange for old or broken ones, for $3.50 and $5.00 each. All tubes are tested before shipment, but the 'X,' or $5.00 bulbs, are tested for the maximum possible sensitiveness. With the audion you can easily increase your range from 50 to 100 per cent."

Our first audions made use of tantalum filaments. Usually, a double loop filament was employed, with three pigtail leads, so that one or the other loop might be used. When one loop or filament burned out, another was still available, thereby giving the short enough life of those audions a double span, so to speak. The tubes were quite gassy. The plate voltage had to be delicately adjusted so as to be set at the most critical value. If increased beyond a given point, the tube would suddenly light with a purplish glow, and the signals would become garbled.

In time, the audion came into use for telephone purposes. It was in 1915 that the American Telephone & Telegraph Company, employing the DeForest amplifier, inaugurated the first transcontinental telephone service between New York and San Francisco. The same year that organization, using my oscillions or oscillating audions, made successful wireless telephone tests between Arlington, Va., and the Eiffel Tower, in Paris, and again with Pearl Harbor, in Hawaii. So thoroughly convinced were wire and wireless men of the value of the audion that the device received no end of research and engineering development. In 1917, I entered into an agreement with the American Telephone & Telegraph Company, whereby that organization secured certain rights under the DeForest audion patents, and whereby sufficient audions might be made available to the Army and Navy for radio communication during the World War. The telephone company, in turn, relicensed others to make and use the audion, so that today every reputable vacuum tube manufacturer is a (*Continued on page* 1039)

The National Federation of Radio Associations recently met in Cleveland for their annual get-together. The above photo was taken at the banquet attended by the 350 delegates

Current

By Stuart C.

A BILLION dollars' worth of radio business this year is the goal set by leaders in the industry at the annual convention of the National Federation of Radio Associations held recently in Cleveland. The $850,000,000 mark which was set last year exceeded, by 16 per cent., the preceding year's volume, considered at the time an unprecedented record in the business world, in view of the tender age of the industry.

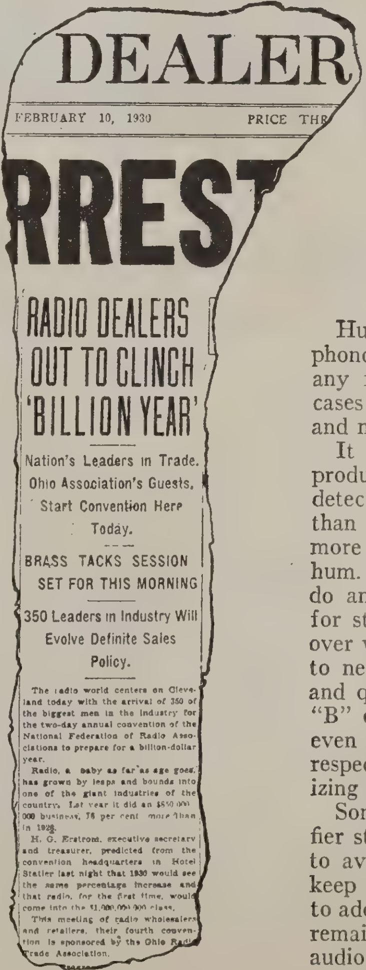
Pentodes

At a meeting of tube and receiver engineers, held under the auspices of the Radio Manufacturers' Association in New York the experts decided, after a lengthy discussion that the "development of the pentode has not progressed to the point where any definite conclusion can be reached, and that there may be possibilities which are as yet not definitely known."

A number of leading manufacturers, including the Philadelphia Storage Battery Company, makers of the Philco receiver, and the Stromberg-Carlson Telephone Company, declared flatly that their organizations would not manufacture pentode-equipped receivers for exhibit at the trade show to be held at Atlantic City in June.

A New Humless Tube

A new development of interest to every radio fan is the perfection of a tube for a.c. operation that is entirely free from hum. It promises to meet with ready acceptance when it becomes available on the market. Following is a description of the tube, written especially for RADIO NEWS by its inventor, Benjamin F. Miessner,* of Short Hills, New Jersey:



DEALER

FEBRUARY 10, 1930 PRICE THR

RREST

RADIO DEALERS OUT TO CLINCH 'BILLION YEAR'

Nation's Leaders in Trade, Ohio Association's Guests, Start Convention Here Today.

BRASS TACKS SESSION SET FOR THIS MORNING

350 Leaders in Industry Will Evolve Definite Sales Policy.

The radio world centers on Cleveland today with the arrival of 350 of the biggest men in the industry for the two-day annual convention of the National Federation of Radio Associations to prepare for a billion-dollar year.

Radio, a baby as far as age goes, has grown by leaps and bounds into one of the giant industries of the country. Last year it did an $850,000,000 business, 16 per cent more than in 1928.

H. G. Erstrom, executive secretary and treasurer, predicted from the convention headquarters in Hotel Statler last night that 1930 would see the same percentage increase and that radio, for the first time, would come into the $1,000,000,000 class.

This meeting of radio wholesalers and retailers, their fourth convention is sponsored by the Ohio Radi Trade Association.

Reproduction of front-page story which appeared in the Cleveland *Plain Dealer*

The hum produced by present-day a.c. radio tubes has been a disturbing and objectionable drawback to the otherwise wonderful performance of many a.c. receivers, not only to the general public who use them but also to the designers and manufacturers who build them.

Hum in a radio set, like the needle scratch of a phonograph, is too well known and disliked to require any further explanation. In the great majority of cases much of this hum is caused by the tubes used and mostly to the tube in the detector socket.

It is understandable that the detector tube should produce the most hum in the loud speaker—while detector tubes produce neither more nor less hum than other tubes, the fact that its hum is amplified more than that of other tubes explains its greater hum. Set manufacturers, unfortunately, are unable to do anything about it. Their sets must be designed for standard tubes, produced by tube manufacturers, over whom they have no control. While it is possible to neutralize tube hum, if it is the same in quality and quantity for all tubes, by bucking action with a "B" or "C" supply ripple, the fact that these tubes, even of the same construction, vary so much in these respects that they present great difficulties to neutralizing remedies.

Some manufacturers have cut out one audio amplifier stage or have used a low gain two-stage amplifier to avoid or reduce this detector tube hum. But to keep a satisfactory over-all sensitivity they have had to add another r.f. stage. In doing this the hum really remains at about the same level, since it shifts from an audio to a radio or "modulation" type.

An audio hum, it may be explained, is one originating in the audio system chiefly in the detector tube; a radio or modulation hum originates in the radio system, principally in the last r.f. and detector tubes. The detector tube may have both types, since it is

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Mr. Miessner is a regular contributor to RADIO NEWS. Elsewhere in this issue will be found an article on the subject of hum in radio receivers and steps which he has taken to bring about its elimination.

Comment

Mahanay

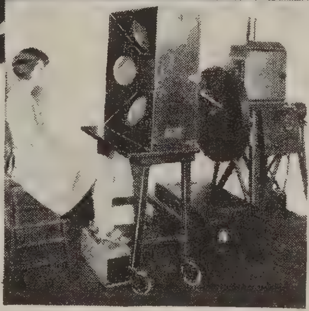
both an r.f. and an a.f. tube. This hum only appears when a carrier wave is tuned in, and increases with strength of the carrier wave in the receiver and with the strength of the hum caused in the tube. This type of hum is very generally mistaken for transmitting station hum. While some broadcasting stations do have some hum modulation in their carriers, the better ones do not. If all stations tuned in strong produce hum, it is a safe sign that the hum is caused by modulation in the receiver.

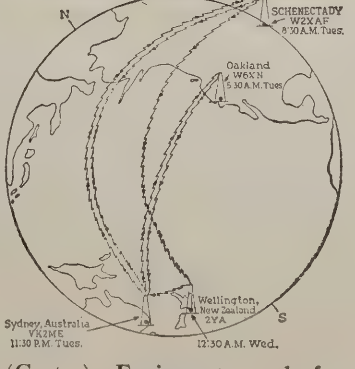
Generally the practice for hum tests has been to tune out all stations and then listen, but needless to say this is only half a test; one for modulation hum, as above described, will provide the other half.

The effort to reduce the tube hum, by reduction of audio gain, therefore, is not a good solution of this problem. The only really satisfactory solution, it seems to me, is a tube which does not hum. Such a tube may be used in existing sets with high audio gain, made during the past few years, and, particularly in the detector socket, will stop the tube hum of the set. It is just as applicable in the r.f. and detector sockets of some of the recent receivers with low audio and high radio gain.

I have produced tubes which produce absolutely no hum. These tubes are not radical departures from the present '27 type in construction except in certain details. They perform the same, operate on the same voltages, may be used interchangeably with present type '27's, and act precisely the same with the exception that they do not hum. They are no more difficult or costly to produce than standard types.

(Above) Control room of the short-wave transmitter from which television signals were transmitted to New Zealand





N
SCHENECTADY W2XAF 8:30 A.M. Tues.
Oakland W6XN 5:30 A.M. Tues.
Wellington, New Zealand 2YA
S
Sydney, Australia VK2ME 11:30 P.M. Tues.
12:30 A.M. Wed.

(Center) Equipment used for transmitting images. A sign or a black drawing may be substituted for a person. (Below) Path followed by the Schenectady-Wellington television signals

The hum output of '27 tubes now available on the market ranges from about one to four millivolts. The hum of the new tubes, if any there be, has so far resisted all my efforts to measure it with measuring equipment capable of detecting a hum of one-hundredth of a millivolt. With an audio amplifier of the d.c. type, having a gain of seven hundred and an absolutely flat audio characteristic and feeding into a sensitive head phone, no hum is heard through the normal hissing or "shot-effect" noises, produced by all tubes, including those operated entirely on batteries. It appears entirely justifiable, therefore, to designate this as a "humless" tube.

It may be possible in the near future to release details of construction and theory of operation; these must be withheld until the tubes are placed on the market.

A copy of the following letter, which is self-explanatory, was received by Radio News:

H. M. TOWER CORPORATION
863 Boylston St., Boston, Mass
March 5, 1930

Mr. Frank V. Goodman,
Gen'l Sales Mgr., Radio Division,
American Bosch Magneto Corp.,
Springfield, Mass.

Dear Frank: Last night I had a perfectly marvelous and extraordinary experience with Bosch Motor Car Radio.

After the installation was made and completed yesterday in my car, the radio promptly began bringing in programs from far and near, just as soon as it was turned on and without any additional adjustments whatsoever.

After leaving the factory, I went down to our Springfield branch, where we had a sales conference, and it was after 9:30 P. M. when I started for New Haven.

(*Continued on page* 1037)

Constructional Details for The UNIVERSAL Auto

The Rigid Requirements for Car Radio Gives the Custom Set-Builder and Serviceman an Opportunity to Exercise His Talents in a New and Lucrative Field. The Receiver Described Here Embodies Such Outstanding Features as High R.F. Gain, Good Audio Quality, Sturdiness of Construction and Compactness

THIS is the second article by Mr. Bullock on the construction of a specially designed small-sized radio receiver for automobile, airplane and motor-boat use. Much thought and not a little time has been spent in the final layout of the receiver described here and the set-builder will do well to examine carefully the construction as outlined not only for building this receiver, but in profiting from Mr. Bullock's experiences in design for any other car receiver whose construction might be contemplated.

IN the last issue of RADIO NEWS we discussed the problems that influence the design of automobile radio receivers and made a general study of the circuit we adopted. That brought us to a point where we were ready to collect our material and to proceed with the construction.

We wish at the outset to give the warning that this is an outfit that requires accuracy more than most radio assembly jobs. This is caused by the compact arrangement as well as from the fact that we are building our own containing case. It is a machine-screw job that requires an alignment of corresponding holes. But the necessity for exercising care in the laying out, cutting, drilling and assembling really adds to the degree of satisfaction of the completed instrument, as its compactness, neatness and rigidity will stimulate the pride of accomplishment in anyone who delights in building electrical apparatus.

Before going into step-by-step instructions for the assembly, it might be a good idea to become acquainted with the set we are to build. It will make the construction easier, more interesting, and possibly permit the builder to make slight modifications, if necessary, to suit his particular conditions.

An Inspection of the Receiver

It is suggested that reference be made to the photographic illustration, Fig. 4. It will be seen that the set is divided into five tube compartments of equal size, each containing all of the essential components for its respective tube. The tubes are arranged from left to right in the order they appear in the conventional wiring diagram (Fig. 1).

First is the section containing the untuned radio-frequency amplifier consisting of the –24 screen-grid tube, Benjamin flexible tube socket, Lynch double resistor mount, 2 megohm grid resistance, National r.f. choke for screen-grid (this choke fits in a set of spring clips beside the grid resistance), Aerovox .5 mfd. condenser for screen by-pass, Yaxley single tip-jack for antenna connection, and National grid-grip cap for making connection to the grid terminal of the screen-grid tube.

The next enclosure is a tuned r.f. amplifier, made up of one section of a DeJur-Amsco triple variable condenser, National r.f. transformer, Remler r.f. choke for plate circuit, Aerovox center-tap .25 mfd. condenser for by-passing the "B" supply and that part of the heater circuit which is included in the tuned grid circuit, Aerovox .5 mfd. condenser for screen-grid by-pass, National r.f. choke for screen-grid lead, single Aerovox resistor mount for choke, Benjamin 5-prong

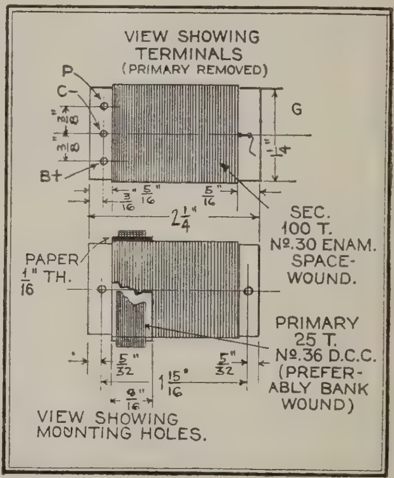

VIEW SHOWING TERMINALS (PRIMARY REMOVED)
P
C–
B+
G
3/16"
5/16"
5/16"
2 1/4"
SEC. 100 T. No.30 ENAM. SPACE-WOUND.
PAPER 1/16" TH.
PRIMARY 25 T. No.36 D.C.C. (PREFERABLY BANK WOUND)
5/32"
1 15/16"
5/32"
9/16"
VIEW SHOWING MOUNTING HOLES.

Fig. 2—Drilling and winding specifications for the tuning inductances are shown above. Three such coils are required

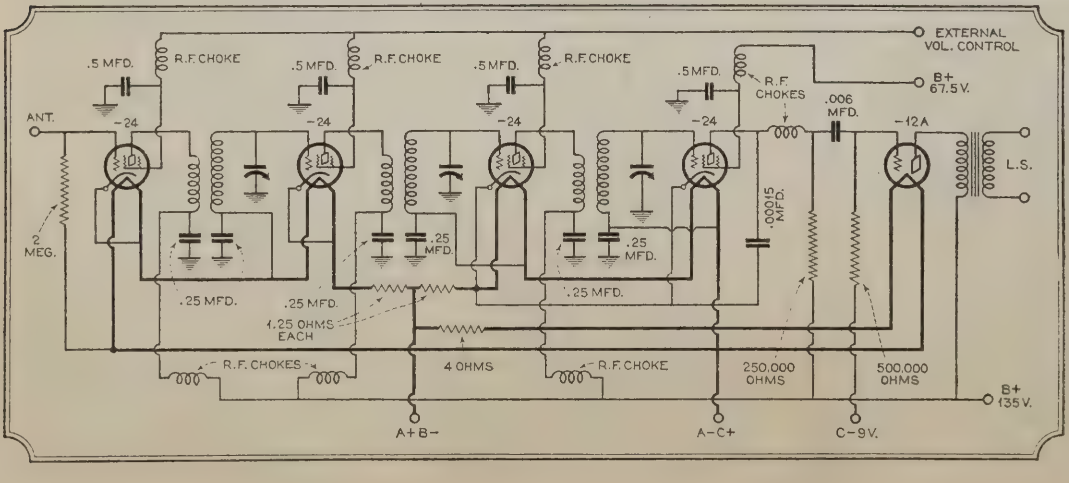


Fig. 1—The circuit employed in the auto receiver. Particular attention is called to the generous use of radio-frequency choke coils and by-pass condensers for stabilizing the circuit

Receiver

By
Walter H. Bullock

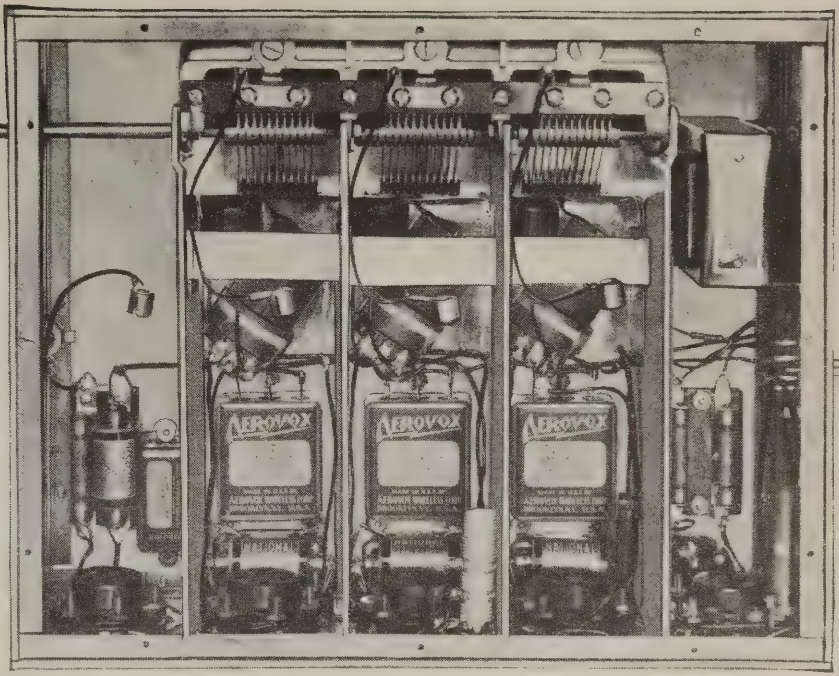


Fig. 4—A close-up of the interior of the receiver, showing the mounting of the components. Although the entire assembly is compact, each unit has been carefully placed to obtain maximum efficiency

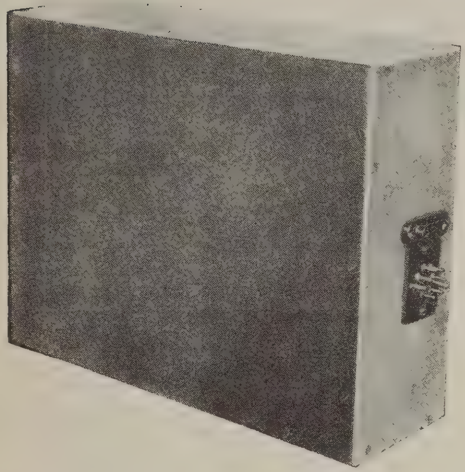


Fig. 3—One of the features of this compact receiver is its neat appearing dust-proof aluminum case, which also provides ample shielding

flexible socket, –24 tube and National connector for its control-grid terminal on the top of the tube. The transverse strip of metal seen just below the variable condenser is part of the tin shielding required in addition to the aluminum partitions.

The third compartment, likewise being a tuned r.f. amplifier stage, contains the same units as the one just described and has in addition a center-tap Electrad resistance seen near the front of the set. This is the resistance shown in the wiring diagram, Fig. 1, connected so as to reduce the voltage drop across the tube heaters in each of the two parallel branches of the "A" battery circuit.

The fourth, or detector section, has the same circuit elements as the first tuned stage, plux an Aerovox moulded condenser of .00015 mfd. capacity connected between plate and cathode. Otherwise the only difference in the two is the electrical distinction of a higher voltage applied to the control-grid circuit and a lower potential on the screen-grid. This, rather than grid condenser and grid leak, brings about the desired rectification of the signals.

The last compartment is the lone audio stage, comprising a Thordarson output transformer, 250,000-ohm plate resistance, 500,000-ohm grid resistance, Aerovox double-resistance mount with .006 mfd. coupling condenser in its base, Remler r.f. choke, Benjamin 4-prong flexible tube socket, –12A power tube, Electrad 4-ohm filament resistance, Yaxley 7-conductor multiple connector, and Yaxley double speaker tip-jack. While our thoughts are centered on this audio amplifier section, it might be explained that an output transformer was used in preference to the choke and condenser type of speaker coupling chiefly as a means of keeping radio-frequency currents out of the loud-speaker leads. By referring to the wiring diagram it will be seen that, with the single-stage amplifier coupled to the detector by means of a condenser, any radio energy that passes the single r.f. choke coil can readily reach the plate of the power tube. With a speaker connection made either directly to the plate or through a condenser, this high-frequency current flows in the speaker leads to an extent that produces a bad coupling effect with the antenna. The distributed capacity and high inductance of the output transformer completely overcomes this difficulty.

While all compartments of the instrument shown are of the same size, in presenting the building instructions we will allow for an increase of ¼″ in the width of the audio amplifier compartment. The advisability of this change results from the fact that we did not get our output transformer until the set was built, and then had to practically dismantle the thing to make it fit in the space we had. An increase of one-eighth inch is all that is absolutely necessary, but we will give it an added eighth for good measure. This will permit the transformer to be turned at right angles to the position shown in the illustration.

To construct the automobile receiver the following parts are specified, not only for their high quality, but for their size and proportions as well. It may be imagined that a design limiting a five-tube screen-grid set to a space of about 525 cubic inches does not permit a very wide selection of parts from which to construct it.

Parts List

7	sq. ft. 3/32″ sheet aluminum
9	ft. ⅜″ angle brass
1	gross ¼″ 6–32 F.H. brass machine screws
2	dozen ¾″ 6–32 F.H. brass machine screws
½	dozen ⅜″ 6–32 R.H. brass machine screws
½	dozen ½″ 8–32 F.H. brass machine screws
100	Spring washers for No. 6 screws
6	dozen 6–32 brass hex nuts
6	Yaxley No. 660 cable connector (7-wire)
1	Yaxley twin-jack speaker terminal
1	Yaxley No. 442 single tip-jack
1	Yaxley pup plug
1	DeJur-Amsco triple unit variable condenser, .00039 mfd. (Specify for RADIO NEWS Auto Radio)
3	Unmounted National radio-frequency transformers, for screen-grid circuit

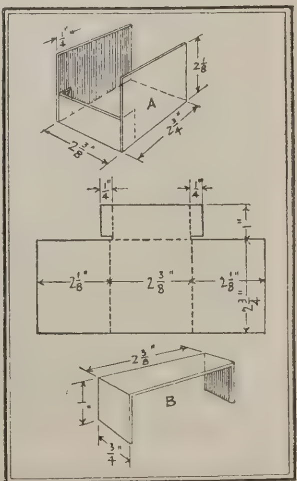


Fig. 5—Details of the shielding employed to stabilize the radio-frequency coils. The position of these stabilizers may be seen in the photograph shown above

4 National grid grips
4 No. 90 National radio-frequency choke coils
3 Aerovox, type 461–225 condenser blocks, capacities .25–c–.25 mfd.
4 Aerovox, type 260 condensers, .5 mfd.
3 Aerovox single-resistor mounts
1 Aerovox No. 1060 double-resistor mount with .006 mfd. condenser in base
1 Aerovox moulded condenser, .00015 mfd.
1 Lynch double-resistor mount
1 Lynch 2 megohm resistor
1 Lynch ¼ megohm resistor
1 Lynch ½ megohm resistor
4 Remler, type 35 radio frequency chokes
4 Benjamin 5-prong flexible tube sockets
1 Benjamin 4-prong flexible tube socket
1 Electrad Truvolt resistance, type B.03, with center tap
1 Electrad Truvolt resistance, type B.04
1 Thordarson output transformer, type 2876
12 soldering lugs
25 ft. sheet tin

NOTE: Switch, volume control, tuning device and other external accessories will be specified and described in the next article.

All of the above parts are quite readily obtainable from any dealer in radio parts. In the event that there is difficulty in locating any of the items, a letter to the manufacturer will clear up the matter. Of course, the screws and sheet stock will have to be purchased from a well stocked hardware dealer.

The Metal Case

We selected sheet aluminum in preference to iron for the case of the set chiefly because it will not rust. Other advantages are its light weight and mirror-like appearance. Nevertheless the builder can use iron if he so prefers. It will be cheaper, will give equal rigidity in a thinner gauge, and though harder, it is a little nicer to work than aluminum. With the latter it is difficult to make a clean cut, whether sawing, filing or drilling, as the metal has a tendency to cling, even to a sharp tool. Where sheet iron is used, its appearance can be improved and it can be fairly well protected against rust by giving it a coat of metallic lacquer inside and out.

We made our case of aluminum sheet of a gauge thick enough (3/32) to permit the countersinking for the flat head machine screws that hold the various faces together and support the parts inside. The metal box is held together at the corners by means of the ⅜-inch angle brass and ¼-inch 6–32 flat head brass screws. The angle brass is tapped for the screws as it would not be convenient to place nuts on the inside ends of the screws, especially after most of the assembly has been completed.

(Continued on page 1044)

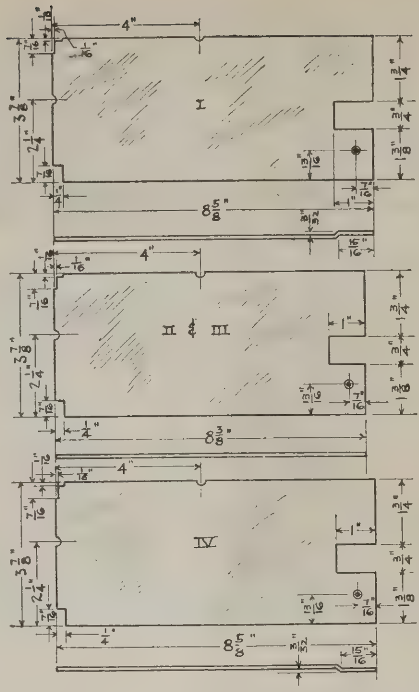
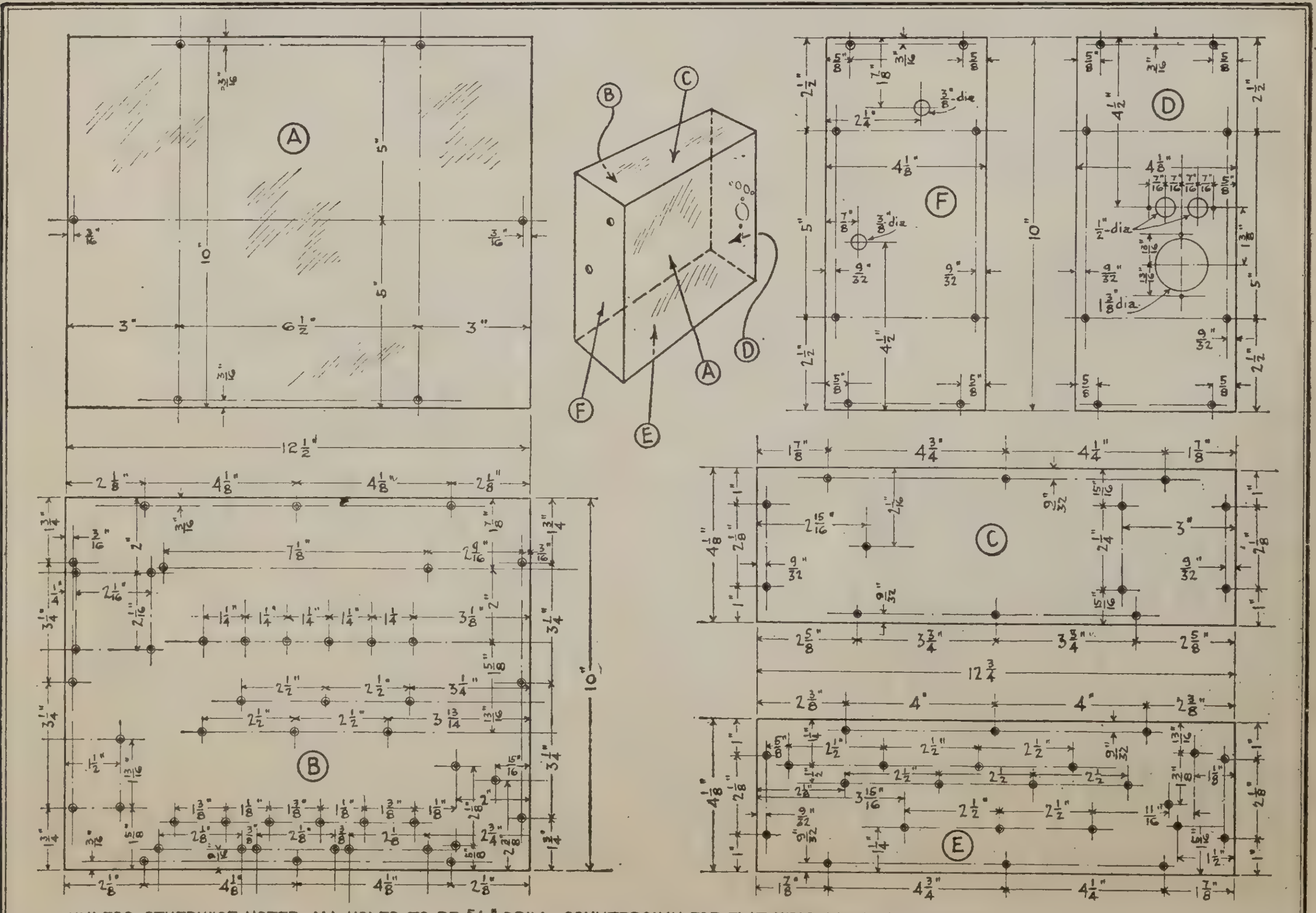
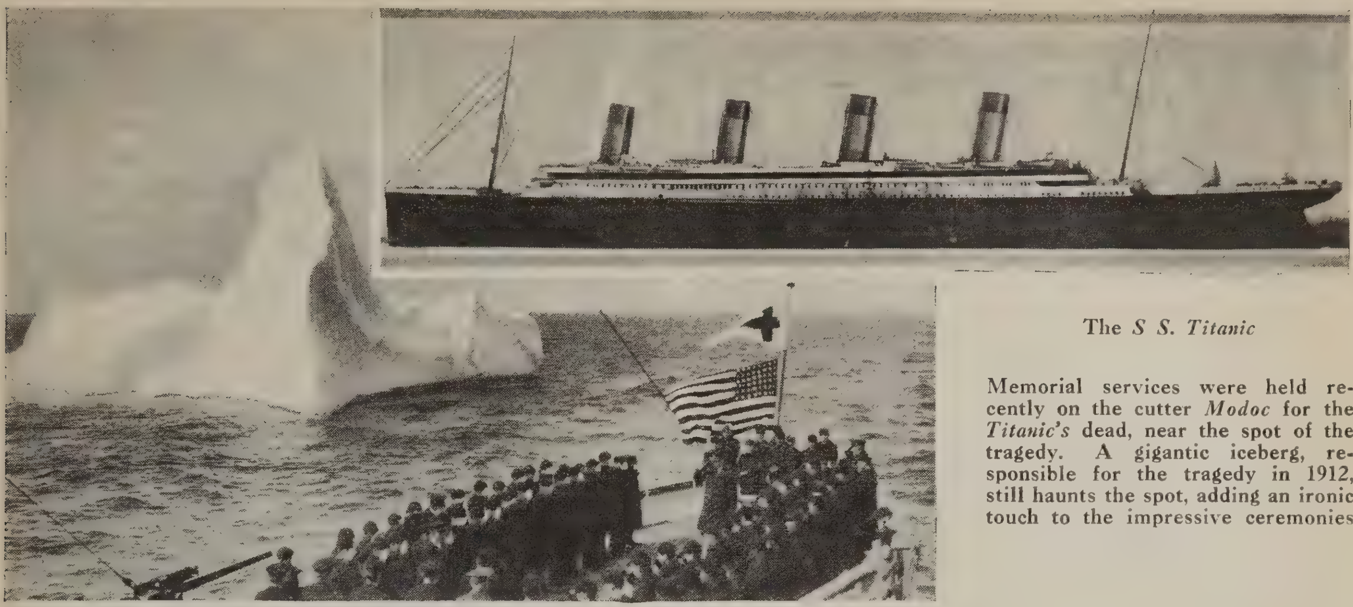


Fig. 6—Above are given the details of the aluminum interstage panels for the complete shielding of each of the r.f. stages

Fig. 7—Below the drilling details for the aluminum case. The perspective drawing in the center will aid in identifying the various lettered panels



UNLESS OTHERWISE NOTED, ALL HOLES TO BE 5/32" DRILL, COUNTERSINK FOR FLAT HEAD MACHINE SCREWS.



The *S S. Titanic*

Memorial services were held recently on the cutter *Modoc* for the *Titanic's* dead, near the spot of the tragedy. A gigantic iceberg, responsible for the tragedy in 1912, still haunts the spot, adding an ironic touch to the impressive ceremonies

A Historic Rescue

The "Titanic" Disaster 18 Years Ago Gave Added Impetus to the Universal Adoption of Radio on All Ocean-going Ships

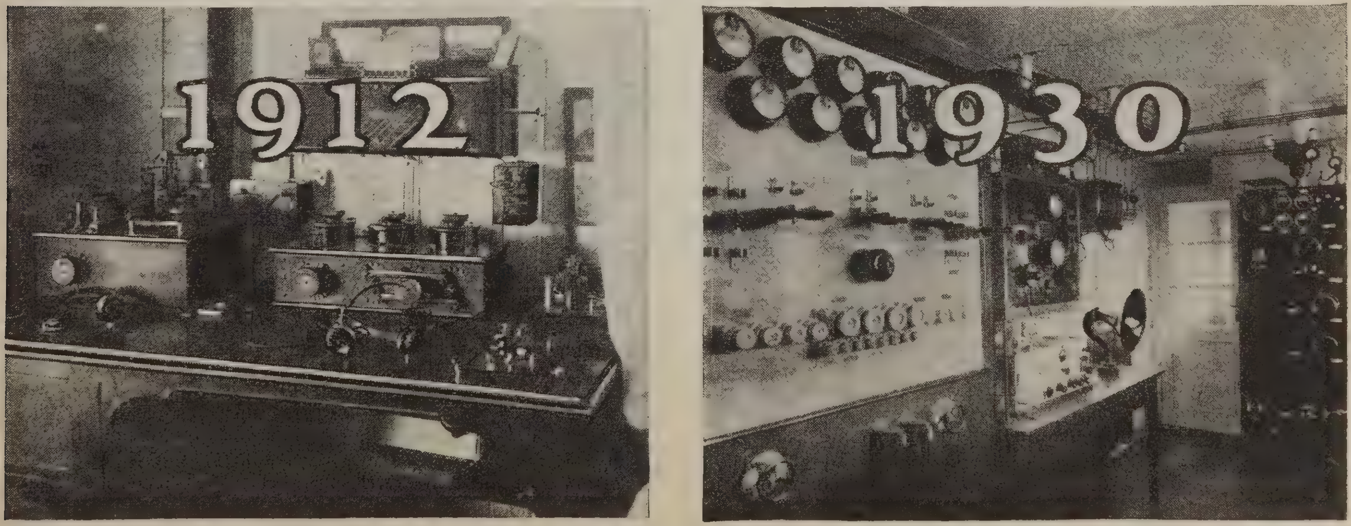
By Orrin E. Dunlap, Jr.

THE steamship *Titanic,* giantess of the sea and pride of marine architects, sailed from Southampton, England, on April 10, 1912, bound on a fatal voyage. Scarcely had the big ship drawn away from her berth when she narrowly escaped collision with the American Line steamer *New York,* which was yanked from its moorings by the tremendous suction caused by the new ship getting under way. That the narrowly avoided crash was the apocalypse of another collision in which the *Titanic* was to play the rôle of a pigmy could not have entered the mind of a single passenger among the gay crowd that ran to the railing to watch the sailors of the *New York* struggle to regain control of their ship in the whirlpools stirred up by the great steel monster of the deep.

Then the big ship gathered headway, moved slowly while in the vicinity of other vessels, but gradually increasing speed as she left the land behind, until finally she was racing proudly and triumphantly through the ocean waves, off at last on her maiden voyage, with Manhattan Island as the goal!

Wireless in those days was not of sufficient strength to keep a transatlantic liner in constant communication with shore throughout the entire voyage unless the messages were relayed by other ships. So the world after reading cable reports of the *Titanic's* gallant departure settled down to await the news of her triumphant approach to New York harbor.

The first dispatch came through the air on Sunday, April 14, when, at 2:15 A. M., the *Titanic* was 1,284 miles east of Sandy Hook, due to arrive in New York at 4 P. M. on Tuesday. But the message which came shoreward on the wings of wireless was a far different dispatch than (*Continued on page* 1049)



The transformation eighteen years of development have brought about in shipboard radio equipment.

Build *this* One-Tube Tuner *for*

Excellent Tone Quality, Because the Design Prevents Sideband Receiver. Selective, and Fairly Sensitive, Considering Amplifier, Provides Plenty of Volume. Can

By John B.

DUE to the very nature of things it was quite in order that, as a result of the popularity which has grown up around the Loftin-White system of amplification, a demand would be created for a simple, inexpensive tuner which would work satisfactorily under the somewhat different conditions imposed by the Loftin-White system over other more common forms of audio amplifiers.

First brought to the attention of the general public by Messrs. Loftin and White in the January issue of Radio News, the amplifiers subsequently described were mainly adaptable for use only with phonograph pick-ups, and to make them work satisfactorily in a radio receiver circuit it was necessary to play a few tricks with the input circuit of the tuner which looked into the first or detector-amplifier tube of the L-W amplifiers.

To satisfy the demand for applying the circuit to radio receiver use, Radio News in its April issue showed how a standard receiver could be revamped to work with the Loftin-White audio system.

In spite of this, however, the need was still felt for the design of a special tuner, purposely built to operate with the L-W amplifiers under the most favorable of conditions.

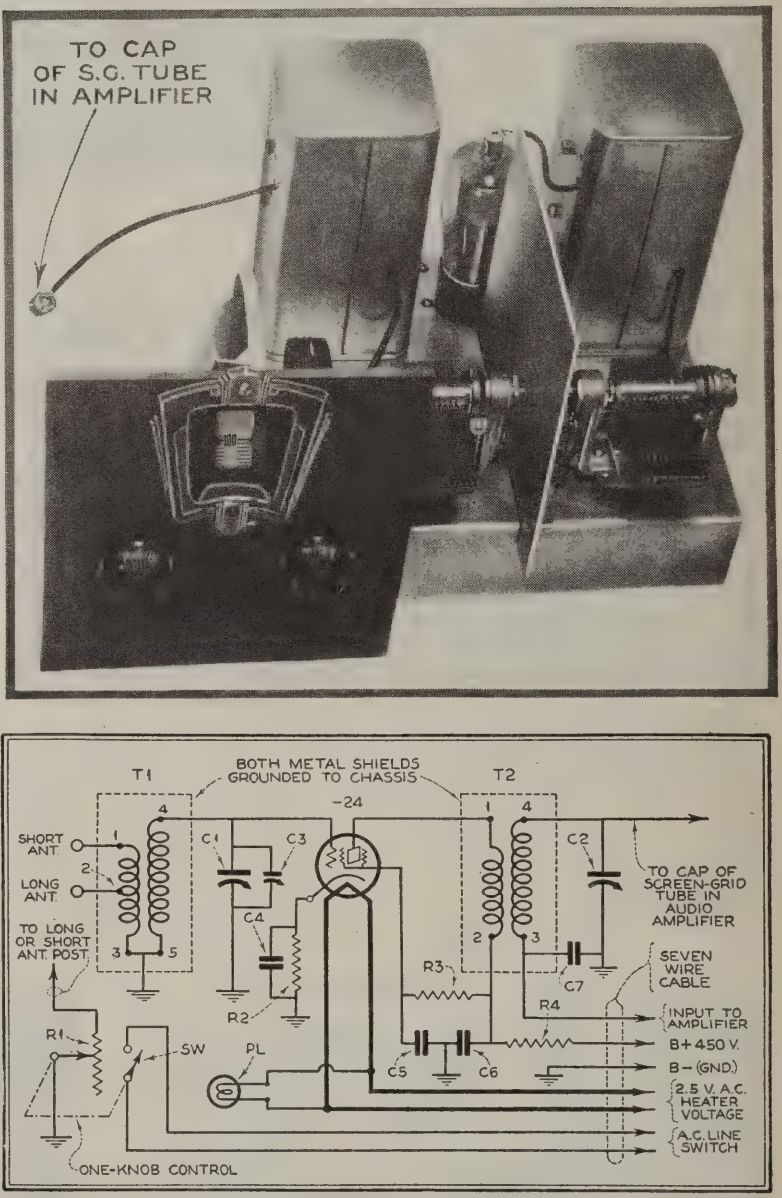
A prominent manufacturer, licensed under the Loftin-White patents, sensed this demand and had his laboratory staff build such a receiver. Radio News is happy to be able to present the constructional details of this receiver to its readers. At a later date it is expected this tuner will be available, in kit form, for custom set-builders.

Tuner Satisfies Demands of Selectivity and Sensitivity

In the very beginning it was decided that, although a multi-tube tuner could be designed, a simpler, less expensive outfit which would satisfactorily meet the demands of (1) good selectivity, (2) sensitivity and (3) no side-band cutting would be more preferable. The photographs accompanying, and the description to follow will show how well these conditions have been met.

In designing this one-tube tuner to go with the Electrad L-W amplifier, the one outstanding requirement from the standpoint of appearance was to make the tuner a companion unit to the amplifier so that, when the two were combined, a harmonious combination would result. Just any old design of tuner would not do. Most tuners, employing two simultaneously tuned circuits by means of a single dial, have the dial located between the two condensers, or, if placed at one end, some other control unit is placed at the other to obtain a symmetrical layout. But here, if that were done, the final panel layout of the complete receiver would be unbalanced with all of the controls at one end and a blank space at the other. Surely not a practice in keeping with present-day trends of receiver design

So, to overcome this slight handicap, all of the tuner controls were brought out to a short length of panel located at one end of the tuner, but, in the final assembly, located exactly between the tuner and the amplifier. A glance at the accompanying photographs will illustrate this point.


TO CAP OF S.G. TUBE IN AMPLIFIER
BOTH METAL SHIELDS GROUNDED TO CHASSIS
T1
T2
-24
SHORT ANT.
LONG ANT.
TO LONG OR SHORT ANT. POST
1
2
3
4
5
C1
C2
C3
C4
C5
C6
C7
R1
R2
R3
R4
SW
PL
TO CAP OF SCREEN-GRID TUBE IN AUDIO AMPLIFIER
SEVEN WIRE CABLE
INPUT TO AMPLIFIER
B+450 V.
B− (GND.)
2.5 V. A.C. HEATER VOLTAGE
A.C. LINE SWITCH
ONE-KNOB CONTROL

Above, the one-tube tuner completely assembled and, below it, its circuit. Practically all of the wiring is done below the chassis, making for a very neat-appearing tuner, as shown

In the layout of the tuner itself use was made of the chassis method of construction, the coils, tube and tuning condensers being located on top, while the by-pass resistors, condensers and wiring are contained below the chassis top.

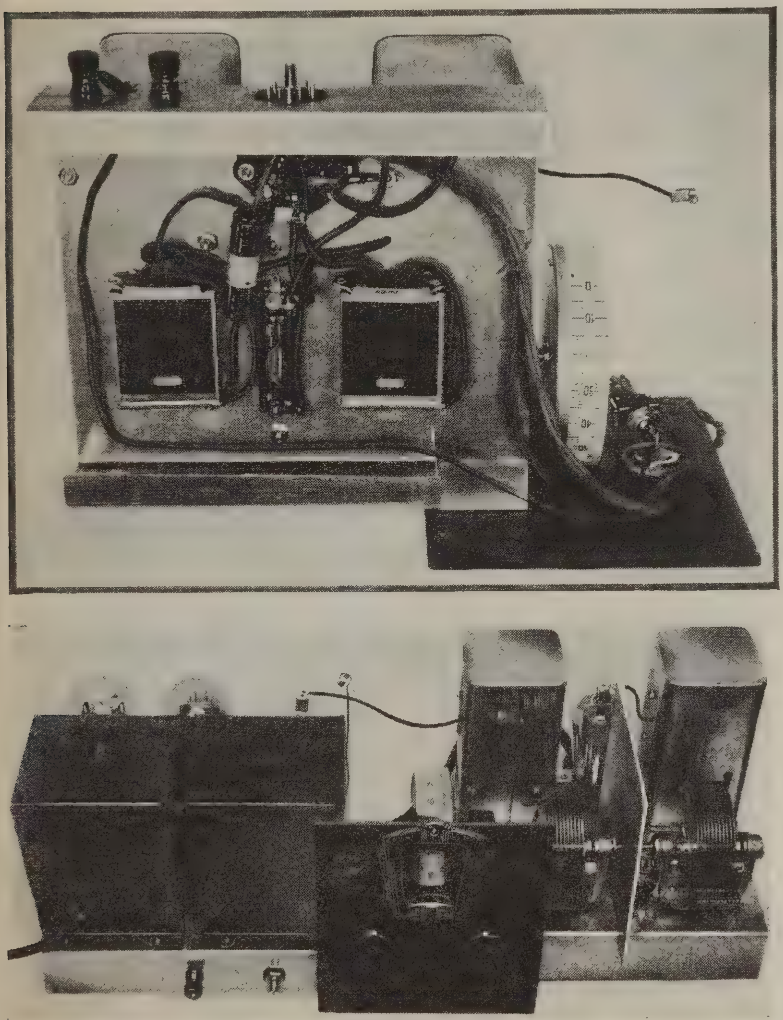
The circuit of the tuner comprises one tuned stage of radio-frequency amplification, a -24 a.c. screen-grid tube being employed.

Unlike most r.f. tuners, only the antenna r.f. transformer,

your Loftin-White Amplifier

Cutting, Is Only One Attribute of This Simply-Constructed Its Single R. F. Stage, the Tuner, With a Loftin-White Be Used Also With Phonograph Pickup

Brennan, Jr.



The bottom view of the chassis, showing the method of mounting and locating the various parts as illustrated above, while below it is a view of the tuner and amplifier combination. The control panel, which before seemed to be at the extreme end of the tuner, is now centered in the middle of the combination, providing a symmetrical, pleasing panel layout

the r.f. tube and the detector r.f. transformer are contained in the tuner, since the detector tube is located in the Loftin-White amplifier.

Both r.f. transformers are totally shielded, being mounted in copper cans which have an outer tinned surface. A sheet of aluminum provides a metal wall between the two tuning condensers, acting as an electrostatic shield between the two to minimize r.f. coupling.

On the control panel, which is fastened to the chassis by means of a queerly shaped extension of the metal sheet forming the chassis, are located the dial window, the dial control knob and the volume control-line switch combination.

Under the chassis are the by-pass condensers and bias resistors, while mounted on the rear side of the chassis and insulated therefrom are the two long-short antenna binding posts.

Circuit Details

The secondaries of both r.f. coils, T1 and T2, are wound to tune to the broadcast band with the aid of the two tuning condensers, C1 and C2, both of .0005 mfd. The condenser C3 is a 35 mmfd. equalizing condenser employed to align the two tuning circuits so that they will track over the entire scale of the dial. Condenser C1 directly shunts the secondary of T1 while, in order to satisfy the circuit demands of the input circuit of the amplifier, only the rotor of C2 is grounded, with the return side of the secondary of T2 connecing directly to the lower input terminal of the amplifier. To complete the r.f. return circuit between secondary coil and tuning condenser, the by-pass condenser C7 of .1 mfd. is employed. The high side of the input is completed through connection of the lead from the top side of the secondary coil of T2 to the grid cap of the screen-grid tube in the Loftin-White amplifier.

Grid bias for the tube in the tuner is obtained by connecting a 600-ohm resistor from cathode to ground. A condenser, C4, of .1 mfd. provides a by-pass across this resistor (the four by-pass capacities, C4, C5, C6 and C7 are housed in two metal condenser cans, each one having three leads protruding from one end. One lead is common to both the condensers in the can while the other two are leads to the .1 mfd. capacities contained therein).

The resistor R4 is of the heavy-duty type and is employed to drop the total voltage of 450 volts coming from the amplifier unit to that required for satisfactory operation of the a.c. screen-grid tube. An additional resistor of the grid leak type, having a value of 500,000 ohms, drops this latter voltage to a value suitable for positively biasing the screen-grid element of the r.f. tube. Both of these resistors are by-passed by capacities of .1 mfd. (C5 and C6).

The volume control resistor, R1, is of the variable type, having a value of 0-5,000 ohms. This resistor is supplied with a power switch so mounted that the resistor control arm also actuates the toggle on the switch to turn on or off the current to the power transformer in the amplifier unit.

All leads coming from the tuner for connection to the amplifier, with the exception of the grid lead from T2, terminate in a seven-wire connector receptacle. The plug for this receptacle is at the end of a cable directly wired into the circuit of the amplifier unit.

Coil Winding Specifications

Two types of coils are used in the two shielded tuned circuits, one an antenna coil with primary and secondary joined together at the low potential end, the other an r.f. coupling transformer having a primary of high enough inductance to work out of an a.c. screen-grid tube.

The antenna coil is wound on a cylindrical tube 1⅝ inches in diameter and 1⅞ inches long. The secondary consists of 63 turns of No. 30 enameled wire space-wound at a pitch of 88 turns to the inch. The primary consists of 30 turns of the

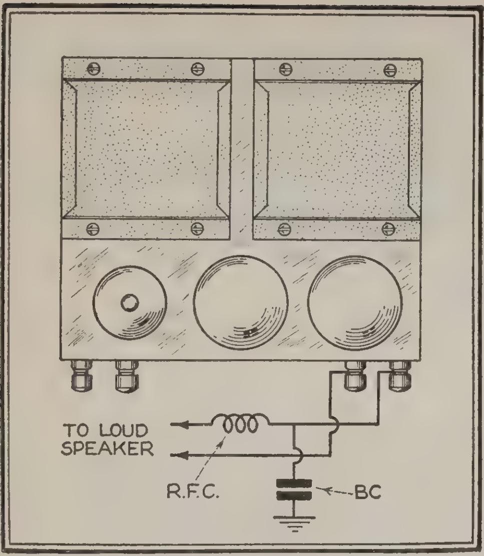


Fig. 1—To prevent the r.f. currents from getting into the loud speaker, an r.f. choke and by-pass condenser, as shown above, should be added to the circuit of the L-W amplifier

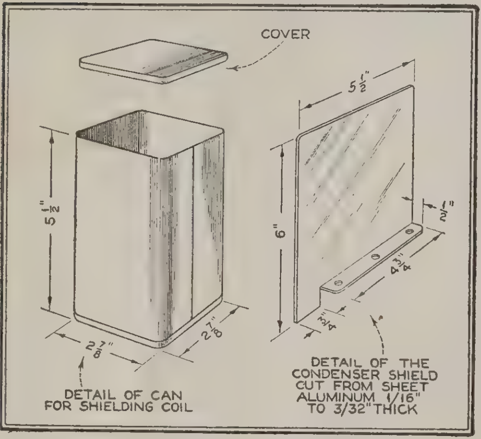

COVER
5½"
2⅞"
2⅞"
6"
5½"
4¾"
½"
¾"
DETAIL OF CAN FOR SHIELDING COIL
DETAIL OF THE CONDENSER SHIELD CUT FROM SHEET ALUMINUM 1/16" TO 3/32" THICK

Fig. 2—Here are the details for forming the coil shield can, two of which are required, and the electrostatic condenser shield which is located between the two tuning condensers

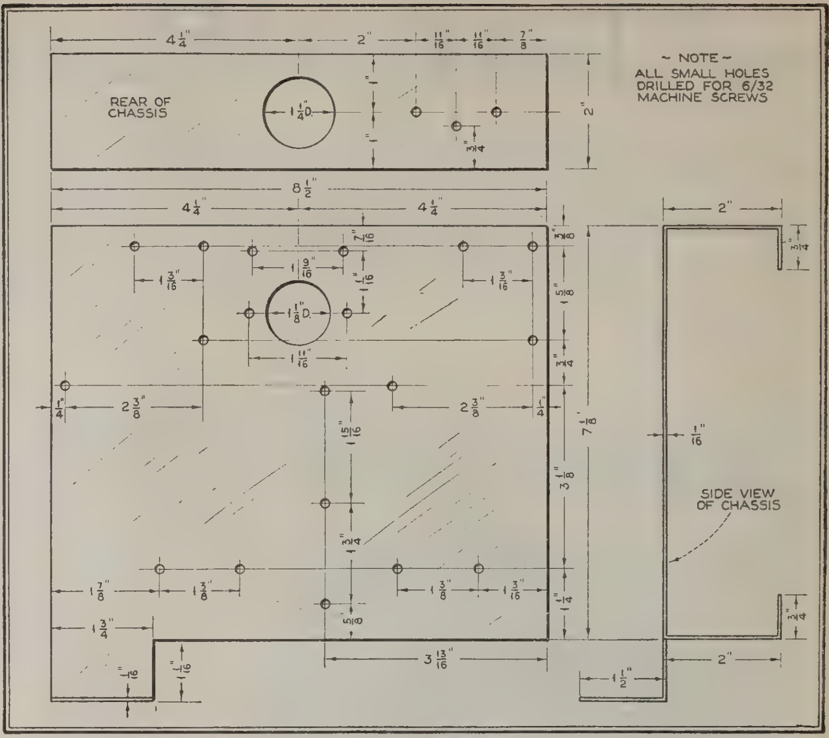
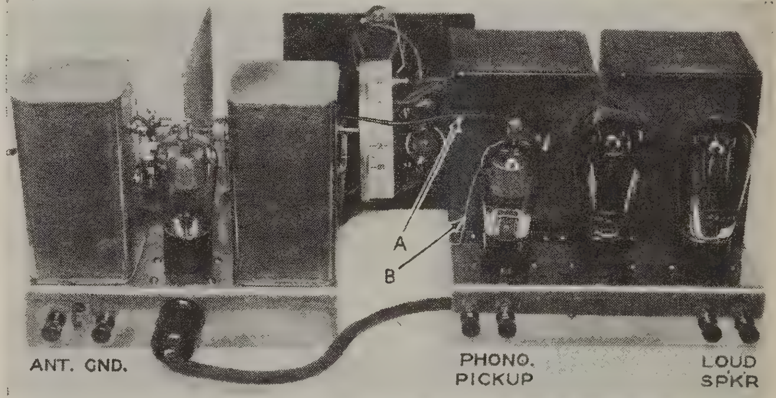


Fig. 3—A piece of 3/32-inch aluminum should be formed and drilled according to the layout shown above to provide the chassis for the tuner. The side view of the formed chassis shows how the extension is made to support the control panel



A rear view of the tuner-amplifier combination. Four tubes in all, including the rectifier, provide you with as compact and satisfactorily performing a receiver as you would want. The lead "A" comes from the tuner and connects to the cap of the screen-grid tube in the amplifier. The lead "B" from the amplifier replaces "A" when it is desired to use the amplifier for phonograph reproduction

same size wire, close-wound, this coil beginning 3/64ths of an inch away from the filament end of the secondary. For accommodating connection of a long antenna to the tuner the primary coil is tapped at the tenth turn.

The r.f. coupler coil is wound on a cylindrical tube 1⅝ inches in diameter and 1⅝ inches long. The secondary is wound with 63 turns of No. 30 enameled wire space-wound at the pitch of 88 turns to the inch. The primary coil of this coupler consists of 40 turns of No. 36 wire close-wound and is located at the filament end of the coil, being wound directly over the lower end of the secondary. A piece of insulating cloth, adhesive tape or paper is used between the primary and secondary to effectively insulate one from the other.

Details of the shielded can construction are shown in Fig. 2. The coil units are centrally located in these cans by means of screws and spacers.

Assembly Pointers

Only the shield cans with their coils and the two tuning condensers with their electrostatic shield are mounted on the top side of the tuner chassis. All other parts, excepting those on the control panel, are mounted underneath the chassis. The photographs which accompany will serve to illustrate the mode of assembly quite well.

With the exception of the grid leads coming out of the coil cans all the wiring of the tuner is accomplished below the chassis, making for a high degree of neatness in final appearance.

Leads which supply the a.c. current to the filament of the lone tuner tube should be twisted to minimize production of hum.

Alterations in the Amplifier

So that the tuner will work satisfactorily with the Electrad L-W amplifier it is necessary to make a few circuit additions to the latter.

Inasmuch as the detector tube is in the amplifier unit the r.f. currents in its plate circuit are passed through to the amplifier output and unless some means for by-passing these r.f. currents are employed, the output to the loud speaker will be garbed and distorted. By the inclusion of an r.f. choke and by-pass condenser between the amplifier and the loud speaker this condition is coped with effectively, the r.f. currents being by-passed to ground. The circuit details for this addition are shown in Fig. 1. The choke and condenser may be very easily mounted underneath the chassis of the amplifier, as shown in Fig. 5. The choke has an inductance of 85 millihenries and the condenser a capacity of .001 mfd.

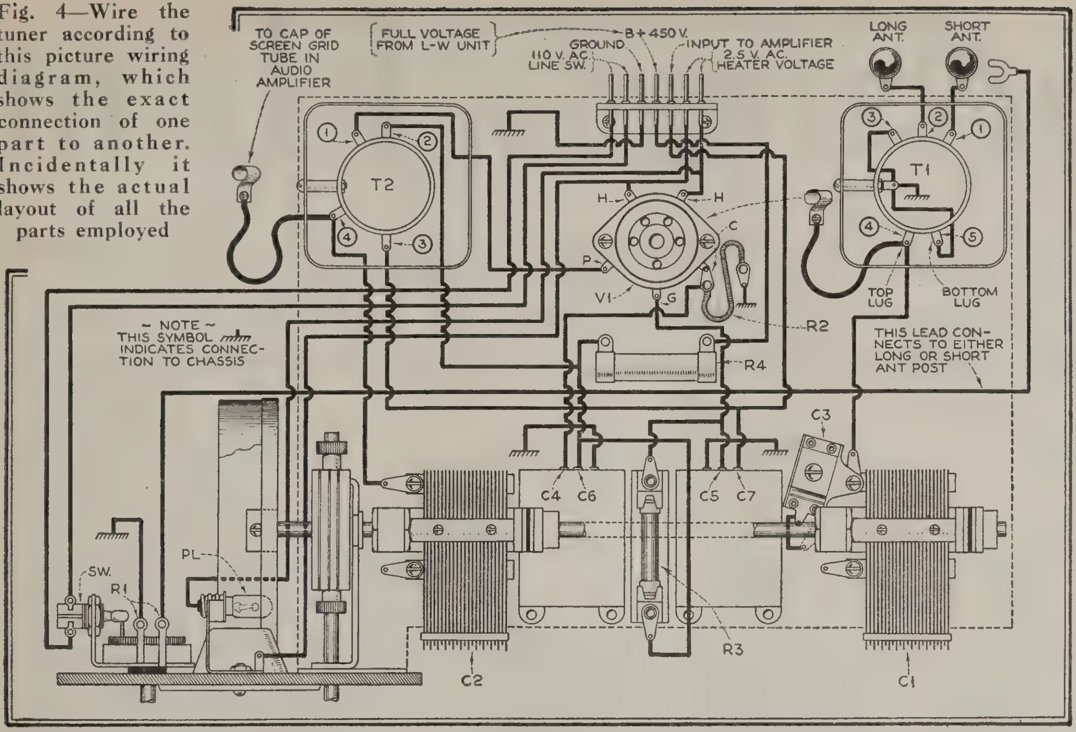

TO CAP OF SCREEN GRID TUBE IN AUDIO AMPLIFIER
FULL VOLTAGE FROM L-W UNIT
B+450 V.
GROUND
110 V. AC. LINE SW.
INPUT TO AMPLIFIER
2.5 V. AC. HEATER VOLTAGE
LONG ANT.
SHORT ANT.
T2
T1
H
H
C
P
V1
G
R2
R4
~ NOTE ~ THIS SYMBOL INDICATES CONNECTION TO CHASSIS
THIS LEAD CONNECTS TO EITHER LONG OR SHORT ANT POST
TOP LUG
BOTTOM LUG
C3
C4
C6
C5
C7
SW.
R1
PL
R3
C2
C1

Fig. 4—Wire the tuner according to this picture wiring diagram, which shows the exact connection of one part to another. Incidentally it shows the actual layout of all the parts employed

The end of the cable from the tuner is wired directly to the amplifier circuit, underneath the chassis. Filament supply for the tuner is taken directly from the filament terminals of the screen-grid tube in the amplifier. Plate voltage for the tuner is obtained by connecting the plate lead to the high end of the power supply.

To turn both tuner and amplifier on and off, one side of the a.c. supply to the power transformer is broken and the two control leads coming from the toggle switch in the tuner are joined to the two ends of this break.

How to Operate the Tuner-Amplifier

As a radio receiver, all that is necessary to operate the outfit is to connect the clip lead from the detector coil in the tuner to the cap on the screen-grid tube in the amplifier, providing, of course, the cable from the amplifier has been plugged into the receptacle in the tuner.

For use as a phonograph amplifier the phonograph pick-up may be permanently connected to the two input terminals on the amplifier and then, when it is desired to change from radio to phonograph reproduction, the tuner screen-grid lead is removed from the screen-grid cap and replaced by the clip lead coming out of the top of the amplifier chassis.

Parts List

C1, C2—Hammarlund midline condensers, .0005 mfd.
C3—Hammarlund equalizer, 35 mmfd.
C4, C5, C6, C7—Electrad two-section by-pass condensers, each .1 mfd.
R1—Electrad tonatrol with a.c. switch, type P-P
R2—Electrad wire-wound grid resistor, 600 ohms
R3—Electrad grid leak, ½ megohm
R4—Electrad enameled wire-wound resistor, 150,000 ohms
T1, T2—Antenna coil and r.f. coupler coil, wound as described in text.
Two coil shield cans as shown in Fig. 2
One chassis, as shown in Fig. 3
One electrostatic shield, as shown in Fig. 2
One Hammarlund drum dial
One Eby a.c. socket
Two Eby binding posts
One Electrad grid leak mount
One Yaxley connector cable and plug No. 660

(For Amplifier)

One Hammarlund r.f. choke, No. 85
One by-pass condenser, .001 mfd.

An objectionable hum may be produced when the receiver combination is turned on, ready for use. This hum may be caused by two things. First, the hum-balancing potentiometer in the L-W amplifier may not have been adjusted correctly. Insert the blade of a screwdriver in the slotted shaft of the potentiometer, located on the back side of the amplifier chassis. With either the radio or phonograph input turned off, depending on which one happens to be connected at the time of test, slowly rotate the shaft over a small arc, noting the diminishing of the hum. A point will be found in this adjustment where the hum is at a minimum or completely eliminated.

The second cause for hum may be found in the fact that the amplifier chassis is not grounded. There is a binding post provided for the purpose right alongside the hum-balancing potentiometer. As a matter of fact, before an attempt is made to balance out the hum with the aid of the potentiometer it would be well to ascertain whether or not the ground connection has been made. Otherwise it will be found that the amplifier is quite unstable, balking all efforts to make it hum-proof.

Tuner adjustments are slight. With a dowel rod sharpened at one end to resemble a screwdriver adjust the equalizing condenser, C3, noting as you do whether the tuning of the circuit tracks over the entire wave-band covered.

In order to provide the correct operating voltages to the tuner, it should be remembered that the tuner has been designed to work with the L-W amplifier employing a –45 tube in its output circuit. If some readers have an amplifier using a –50 output tube, then the size of the resistor, R4, will have to be increased to about 225,000 ohms. The value of resistor R3, however, remains the same.

Once the correct antenna post is determined, depending on the antenna used, the other post may be disconnected from the antenna coil and the vacated post used to ground the chassis of the tuner to the grounded chassis of the amplifier.

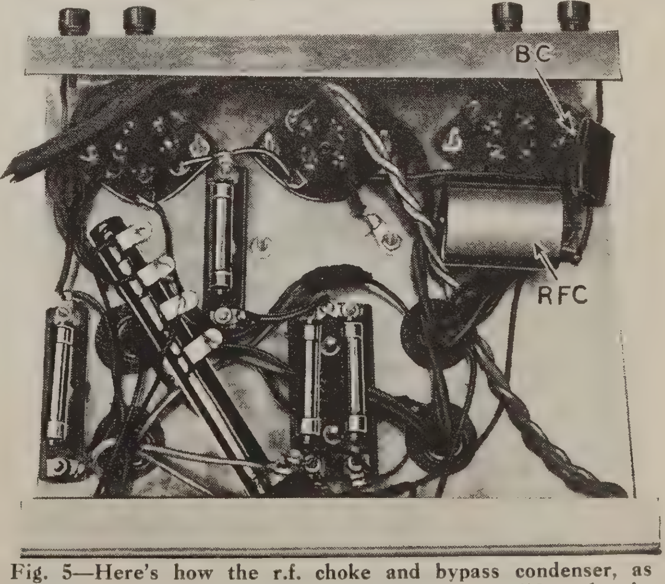


Fig. 5—Here's how the r.f. choke and bypass condenser, as shown in Fig. 1, are mounted beneath the amplifier chassis. "RFC" is the radio-frequency choke and "BC" is the bypass condenser

Analyzing the Hum

A very practical and easily understood discussion of the cause and method of eliminating various kinds of hum by a scientist who has made this subject his life work

By Benj. F. Miessner*

As pointed out in my first article of this series, appearing in Radio News for February, there are a great many sources of hum in present-day a.c. receivers, just as, for example, there are many sources of noise in an automobile. There are also many types of hum, just as in the automobile there are many types of noise, with which many automobile drivers are generally familiar. I have been asked many times by friends over the telephone what to do to their receiver to stop its hum. Needless to say, this is like trying to tell a man what ails him without seeing him, or like diagnosing an automobile noise trouble without listening to it. If you have ever tried to find the cause of a body squeak, or to decide whether a knocking noise is caused by a loose bearing, carbon, slapping pistons, noisy tappets, etc., you will understand to some degree the problems involved in diagnosing a hum ailment in an electric set.

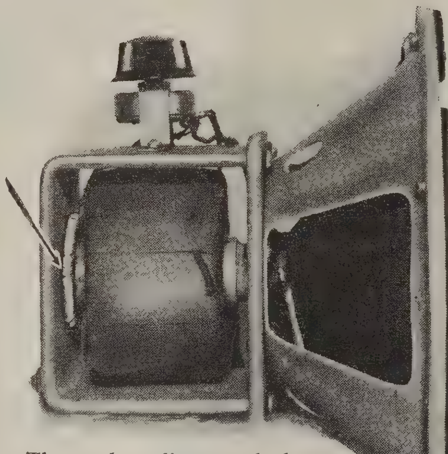
It is not sufficient in designing an electric set to use humless tubes and humless current supply to the tube elements. Many other factors must be considered, since they can cause very objectionable hums, even though the current supply be perfectly smooth.

Outside Hum

While hum-diagnosing methods will be described later I believe that an understanding of the various causes of hum should be understood first, so I am now proceeding to this phase of the subject.

When hum causes are present to a sufficient degree in detector or audio tubes, a continuous hum will be heard in the speaker. A very small amplitude hum of this type may be objectionable because of the usual practice of tuning out all signals when listening for hum. This same fact applies equally well to other types of hum introduced into the audio system.

When the hum causes are present in radio amplifier tubes the hum does not appear until a radio frequency carrier passes through them. Then, if they are strong enough to vary the mutual conductance of the tube, this radio frequency carrier will be modulated, and the modulation will be detected and amplified as a hum.



The author discovered that loud speaker hum can be neutralized by the addition of a small coil around the core, as shown above

¶At a time when all efforts are being bent toward simplification, price reduction and improved performance in radio receivers, it appears incongruous that tubes should be trending oppositely, as witnessed by the changes in the last few years from three to four, and now, with the introduction of the Pentode, to five-element tubes.

¶Under present conditions, receiver designers have no control over tube design and therefore the hum originating in tubes must be accepted or neutralized externally. However, when receiver manufacturers make their own tubes, this undesirable condition has good prospects of being remedied.

¶It is hardly necessary to state that the first audio transformer in the usual two-stage audio system is the most susceptible target for alternating current leakage leads.

¶One make of broadcast receiver had a very objectionable buzzy type of hum because the detector tube was mounted within a few inches of the rectifier tube.

¶My measurements prove with certainty that the –26 type tube hum is just as low as that of the –27.

This type of hum is many times erroneously attributed to the broadcasting station, since it is heard only when a carrier is tuned in. A simple way to check this by ear for a given set or station is to tune in other strong carriers. If all develop this hum it may rather safely be attributed to the receiver, otherwise the particular transmitter is at fault.

It may be remarked here that the amplitude of this modulation hum is determined both by the amplitude of the modulating causes in the receiver, and the amplitude of the carrier current in the r.f. tubes. Because of this fact the modulation hum is usually masked by program modulation of the carrier at the transmitter, and by microphone, tube, and other noises, originating both at transmitter and receiver. The amplitude of the modulation hum as developed in the loud speaker may be controlled by the usual radio frequency volume control in the receiver, as well as by the tuning control.

Humless Receivers with "–26" Tubes

The four-element or heater type of tube eliminates, for all practical purposes, the temperature type of hum present to some degree in the three-element tubes today available. However, the voltage and magnetic hum causes are still present to some degree and in addition other hum-producing causes, such as conduction of filament current through the high temperature insulation between cathode and heater filament, sometimes exist.

When all of the above mentioned factors are properly reckoned with in tube and receiver design, and certainly no severe limitations need be imposed by them on set designs, the three-element tube is capable of performance fully equaling that of the four-element tube. As a matter of fact my measurements prove with certainty that the –26 type tube hum is just as low as that of the –27.

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*Mr. Miessner has applied his hum-reducing methods to receivers made by Stromberg-Carlson, Bremer-Tully, Edison, Kolster, Howard, General Motors Radio Corporation, Culbransen, United Reproducers, All-American-Mohawk, Crosley, and the United States Radio and Television Corporation, for whom he is a consulting engineer.

A corner view of Mr. Miessner's laboratory. To the left may be seen an oscilloscope, one of the instruments which he uses for hum analyses

I am sure that not one engineer in a hundred is aware of this. The tubes at present available are fairly satisfactory in performance and are more easily and more cheaply constructed than the four-element or heater type. Although the present construction provides a lower grid-plate capacity in the four-element tube than in the three-element type, it is easily possible to so construct the three-element tube that this condition will be reversed, and so that the three-element tube will therefore be more attractive for use in radio frequency circuits than the four-element tube. If, instead of the present one and one-half volt filaments, the voltage were reduced to one-half or three-quarters of a volt, as used in the writer's three-element tubes previously described and demonstrated, the filament type a.c. tube may be made to produce less hum than the heater type. It may, therefore, be used for detection, especially with the recent trend of one stage audio systems and plate type of power detectors.

Receivers Cheap but Good

At a time when all efforts are being bent towards simplification, price reduction, and improved performance in radio receivers, it appears incongruous that tubes should be trending oppositely, as witnessed by the changes in the last few years from three to four, and now with the introduction of the pentode, to five element tubes.

Under present conditions, receiver designers have no control over tube design and therefore the hum originating in the tubes themselves must be accepted or neutralized externally. If, however, as it now appears probable, many receiver manufacturers will also manufacture their own tubes this undesirable condition has good prospects of being remedied.

Hum caused by induction is a rather important factor in present-day electric receivers, particularly since the combination of power supply and receiver on one compact chassis has become the design standard. While the older plan, using a separately housed power supply, reduced the likelihood of this type of hum being objectionable, it by no means eliminated it, particularly if the choice of the power box location with respect to the receiver was left to an unskilled installer.

Induction hums may be separated into two classes, due to

(a) Magnetic Induction;
(b) Electrostatic Induction.

In the first class, the power transformer is the worst offender with respect to a.c. leakage field, but there are other important sources which must not be overlooked. Among these is the first filter choke, which, unless preceded by a very large condenser, carries an a.c. current component of considerable magnitude, superimposed on its already saturating d.c. component. This, coupled with the use of air-gaps in the magnetic circuit, to reduce saturation for maximum inductance, sets up a strong a.c. leakage field. This field must be properly respected in physically laying out the receiver.

Troublesome, though less important is the a.c. magnetic field set up by other chokes, such as the output coupling choke sometimes used for speaker circuits, and output transformers, which, because of no succeeding amplification, may carry a considerable filter ripple component without developing objectionable hum in the speaker.

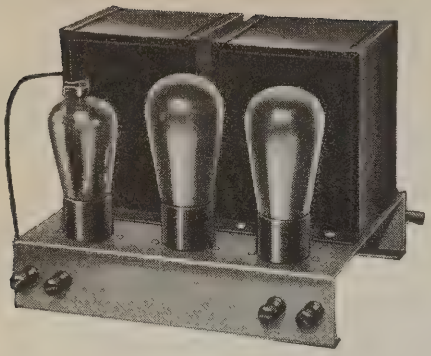
Filament feeder leads carrying several amperes of alternating current may, if run very close to the first audio transformer of a good two-stage amplifier, cause some hum. Only in such cases need the two feeder leads be twisted. The twisting of these filament supply leads has been very much and unnecessarily overdone in the past.

Resistance Coupling Reducing Hum

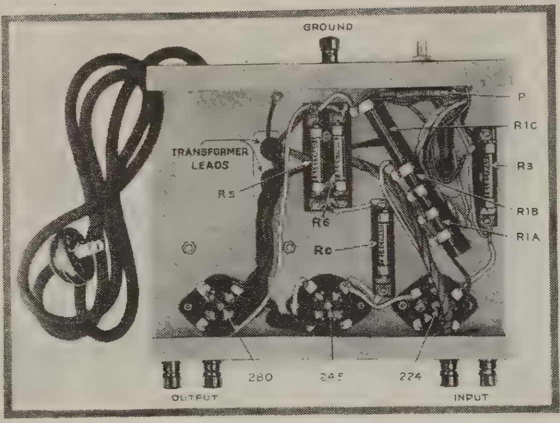
It is hardly necessary to state that the first audio transformer in the usual two-stage audio system is the most susceptible target for these alternating current leakage fields. This is easily understood when it is remembered that any a.c. voltage introduced therein will be amplified ordinarily about a hundredfold by the succeeding amplification. Good amplifiers, of course, demand greater care in layout with respect to induction than poor ones. In this respect resistance coupled amplifiers may be freed from hum caused by this induction.

A poor amplifier may have but little amplification at the predominant frequency of 120 cycles obtained with the usual full-wave rectifier, while at 60 cycles it may be practically nothing, so that power transformer induction requires but little consideration, unless, due to power line harmonics, or harmonics introduced in the transformer itself because of saturation. In this case higher frequencies capable of good amplification by poor low tone amplifiers are picked up and amplified to objectionable proportions in the loud speaker.

High quality amplifiers require (*Continued on page* 1053)



Some Notes on *The* Practical Direct-Coupled



Two views of a Loftin-White amplifier assembled from a kit. The transformer, choke, filter condensers and tubes are on top of the chassis, while underneath are located the resistors with their mounts, the tube sockets and all of the wiring

Photo courtesy Electrad, Inc.

The Fifth of a Series of Articles Describing Technical Details of the Loftin-White System of Amplification. Detection Characteristics of This New System Show Its Greater Selectivity Over Existing Types of Rectification

By Commander E. H. Loftin

FOR the benefit of those who seem to have acquired an erroneous impression that our technical treatment in recent years of the subject of direct-coupled cascaded tube systems infers a claim by us to having originated this mode of tube coupling, we begin this fifth of our series of Radio News articles with a tacit denial of making or having ever made or inferred any such claim. In fact, we referred to the very early origin of the coupling principle concerned in the preamble of our first Radio News article, and also in a number of technical papers on the subject we have delivered from time to time before the radio engineering societies, so that our fact record in the matter is definitely void of any such claim for ourselves.

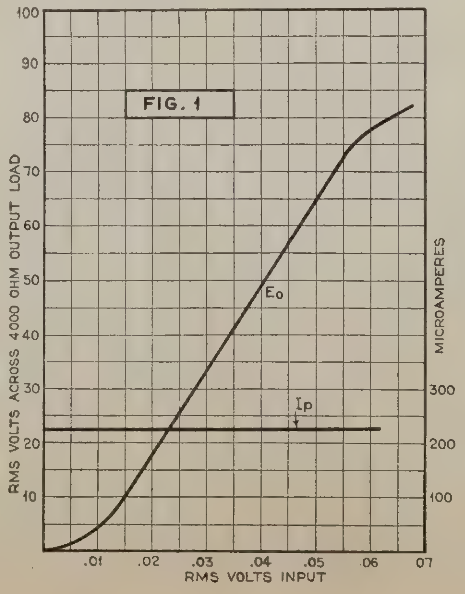
In truth, Fleming of England disclosed direct coupling as early as 1904 in connection with two electrode tubes, and De Forest, Pierce and Langmuir of the United States extended the principle to three electrode tubes as early as 1913. Since these early times telephone engineers and others have repeatedly shown direct-coupled cascaded tube systems in one form or another in various suggested applications and uses, and knowing of these things we unhesitatingly admit on our part that direct coupling is not new. To the contrary, it is aged.

Of significance, however, is the fact that in spite of the great age and always obvious fundamental correctness of the principle, no one ever encountered a direct-coupled cascaded tube system (any variety) outside of a laboratory during all the years, with which many of us are familiar, of demonstrated great earning ability of other cascaded tube systems.

Thus all we claim in fact is to have discovered that a good breed which had suffered so long from the "pip," so to speak, as to be universally abandoned as incurable could, with reasonable treatment, be vitalized into the finest-voiced, healthiest crowing cock of the roost and, of particular importance, feeds on a.c., the most economical of the lot.

Enough of ancient history. To those interested in knowing our views of the nature of the "pip" we found in the breed, and the various steps taken to arrive at cures and subsequent economical a.c. diet for it without digestive (hum) disturbances in advance of our treatment of these matters in this series of articles, we invite particular attention to a recent paper before the Institute of Radio Engineers now announced to appear in the present April

Another L-W amplifier, with only the tubes and line transformer showing



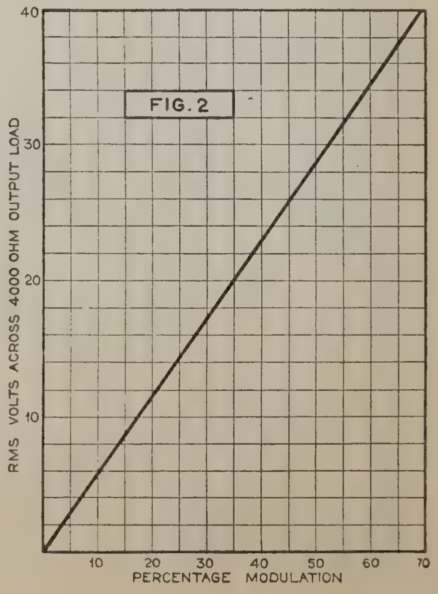
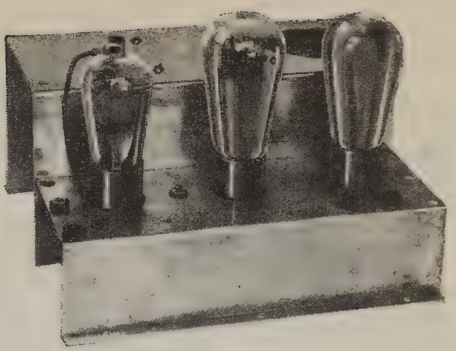


Fig. 1—An input-output curve of a typical Loftin-White amplifier, showing its substantially linear detector characteristics. Fig. 2—A curve indicating the "no modulation discrimination" of the L-W system

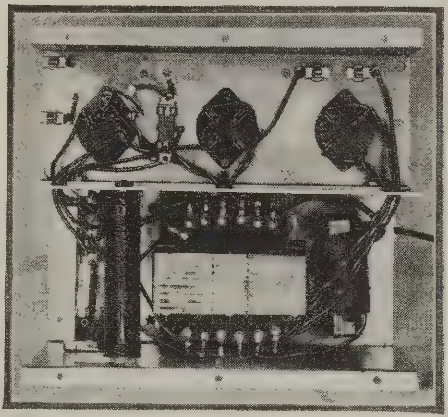
OPERATION of Amplifiers



THE tremendous interest which this new system of audio amplification has aroused is by no means unwarranted, and manufacturers and experimenters alike are awakening to its vast possibilities and the important part it will play in radio and sound amplifier development.

In this article the authors present some highly interesting technical data on the Loftin-White system of amplification with graphs which clearly illustrate the difference between this system and the more common methods of detection and amplification.

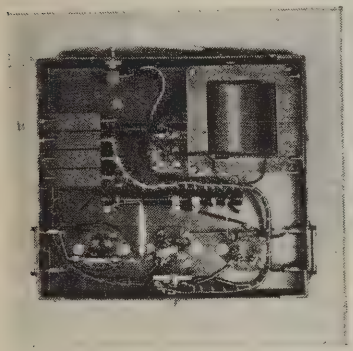
Succeeding issues of Radio News will tell how the Loftin-White system can be applied to broadcasting station equipment.



The top and below-the-chassis view of this amplifier which employs the Loftin-White circuit indicates a somewhat different mode of assembly. The chassis is composed of two distinct metal forms, one supporting the tubes, the other housing the transformers, resistors, etc.

Photo courtesy Amplex Instruments Corp.

and S. Young White



The under side of the amplifier to the left showing location of parts below the chassis top

Photo courtesy Wholesale Radio

Proceedings of the Institute.

In our preceding four Radio News articles we have touched but briefly upon the theoretical aspects and fundamental considerations involved in direct-coupled cascaded tube systems as we view them, having been diverted from our plan to do so in meeting requests for data for the construction of devices bringing into use some of the principles involved and some of the functions of which the systems are capable.

As a result we have so far covered a two-tube, –24 input and -50 output, all-electric energized system usable for either carrier current detection and amplification and audio amplification in the second article; a two-tube, –24 input and –45 output, all-electric energized system, usable as before, in the third article; and an addition of three stages of screen-grid radio-frequency amplification to the system of third article in the fourth article, thereby strongly calling upon the automatic grid bias change and stabilizing effect in the –24 input tube, discussed principally in the second article, for best operation.

We were at first reluctant about changing our plan to the procedure actually followed as above outlined in the belief that it would be only fair to endeavor through a "course of sprouts," so to speak, to outline reasons for advising the structures we have given as typifying some of the embodiments of all-electric direct-coupled cascaded tube systems. Now that we have had opportunity to review many expressions of successful verification of our results from trials with our data, we feel convinced that our first fears as to the advisability of the procedure we reluctantly adopted arose in the difficulties we encountered during our own development stages in proceeding without guidance other than the elusive indications of trial and error.

In specifying in our fourth article the development of the two-tube system of the third article to include three stages of radio-frequency amplification we neglected to comment that the radio receiver so arrived at does not represent the ultimate in economy that can be achieved when starting a radio receiver design afresh. We had already provided Radio News readers with the data for the two-tube system of the third article, arrived at without any expectation of having it later include radio-frequency amplification, so that when we were asked to add (*Continued on page* 1054)

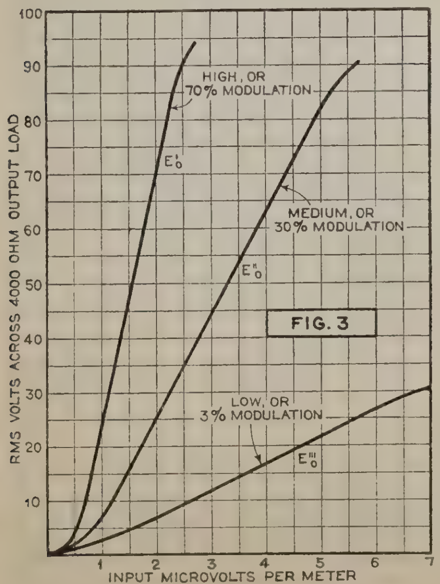


FIG. 3

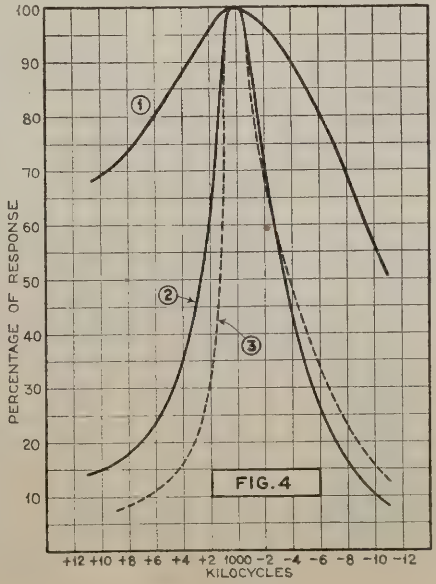


FIG. 4

Fig. 3—For three different percentages of modulation the detection performance of the complete receiver, as described in the April Radio News, is indicated by three curves shown. Fig. 4—Comparison curves which show the greater selectivity of the L-W type of detection over the grid and plate types of detection

ANALYZING RECEIVER

Poor tone quality does not always mean that your loud speaker or tubes or transformers are causing distortion. This unbiased discussion analyzes the receiver as a whole and tells first, where to look for distortion, and second, how overall receiver design compensates for distortion produced by individual units

¶ It may be interesting to note that natural reproduction from the radio set will usually be accomplished by an unfaithful reproduction of that which is sent out by the broadcasting station.

¶ No single unit of a receiver plays a more important part than any other.

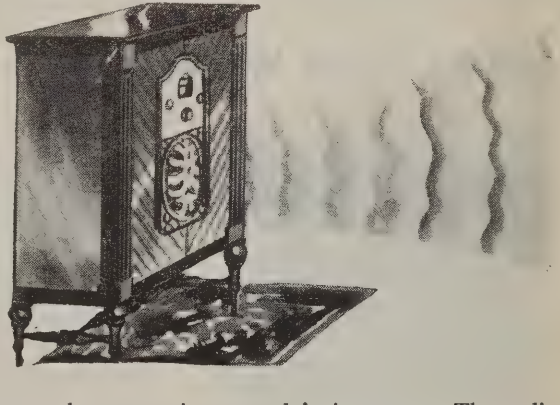
¶ All audio systems discriminate against the very high and the low frequencies.

¶ All loud speakers give distorted outputs.

¶ Each unit in a radio receiver can, and usually does, introduce distortion.

SINCE the fidelity of musical reproduction has become of recognized importance, the problem of tonal balance has added one more difficult question to the design, manufacture, and personal selection of a radio receiver. The author has read many articles on speakers, transformers, and r.f. tuning devices—how if one uses the "X Speaker" one will then have the best possible tone—or how a "Y Transformer" will end the problem of low note response—or even how the "Z Method" of tuning will give enormous selectivity with true response over the audio range.

This article is an effort, by an unbiased writer, to clear up many of the misunderstandings which the trade, as well as the general public, have with regard to the "secrets" of good tone quality. Possibly a good bit of confusion is occasioned by the lack of suitable definitions for quality. Some people enjoy overemphasized bass, others seem to prefer an entire lack of the lower register. However, it can easily be seen that within a very short time the majority will demand "natural" reproduction, for, after all, good music is that composed and rendered by artists—not that which has been changed by radio receivers and transmitters to meet technical design problems. So instead of the commonly heard terms used to distinguish loud speaker musical outputs, it would be better to use two general classifications—Natural and Unnatural reproduction. The latter could be subdivided into overemphasis of low, middle, or high frequencies. It may be interesting to note that natural reproduction from the radio set will usually be accomplished by an unfaithful reproduction of that which is sent by the broadcasting station. The larger stations are now quite standardized on the type of output performance used, so this discussion may become quite general in its scope. The radio voltage or signal appearing across the antenna-ground binding posts of the receiver will be the starting point of this treatise.



Every receiver consists of four distinct units — the radio frequency selector and amplifying

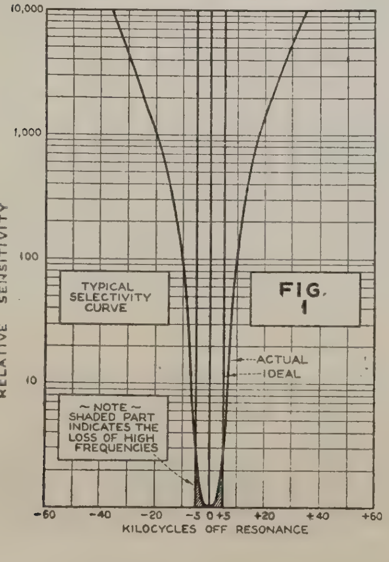


Fig. 1. The ideal frequency response of a tuned circuit is obtained when a band of ten kilocycles is covered, the response being flat at the top with an abrupt cut-off at the sides. To the left is shown the curve of an ideal and a typical tuning circuit

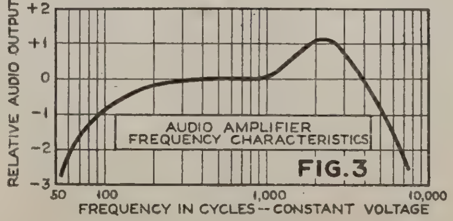


Fig. 3. In the realm of audio frequencies we strive for an equal level of amplification for all audio frequencies. The curve above shows how near, or how far away we are from this ideal

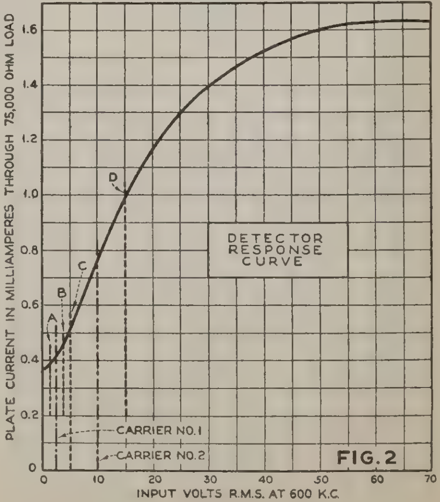


Fig. 2. This detector response curve shows that at low signal levels the output is not directly proportional to input, while at high signal levels and at low percentages of modulation this detector would give quite an undistorted output

DISTORTION

By R. M. Somers

MR. SOMERS, while a new author to RADIO NEWS *readers, is not a newcomer in the radio field.*

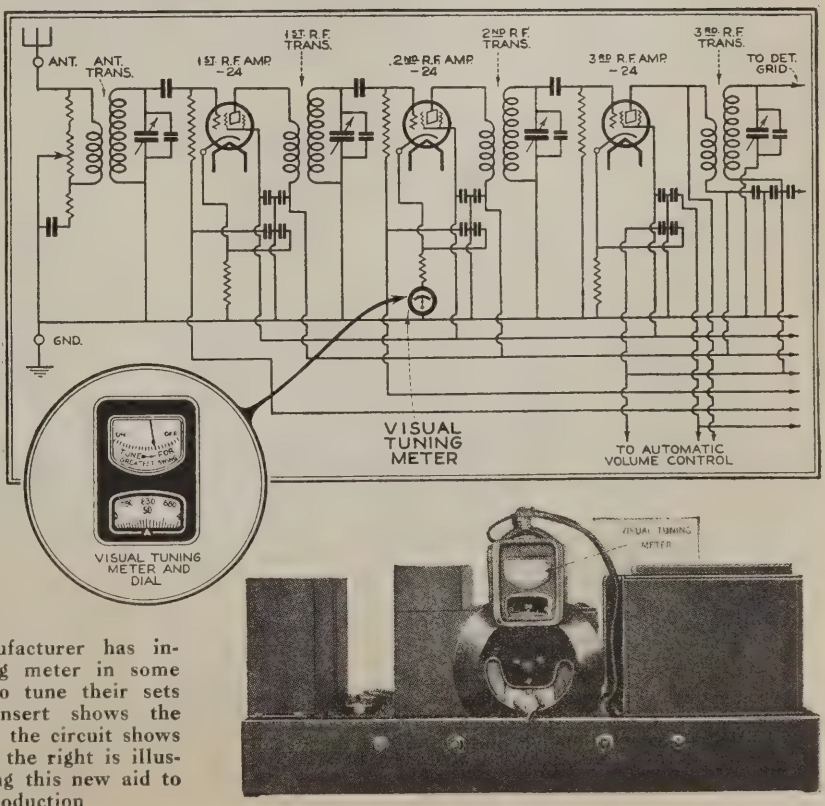
During and after his matriculation at Rensselaer Polytechnic Institute he was a "ham" operating his own station, 2COC.

First as an instructor in mathematics at his alma mater, then with the Radio Corporation of America engaged in transoceanic transmission work he is now associated with Thomas A. Edison, Inc., as a research engineer. His experience qualifies him to write with authority on the subject of receiver distortion.

system, the detector, the audio system, and the reproducer. No single unit plays a more important part than any other. Defects in any one or even two units can be more or less corrected by opposite defects in the others. These statements of course are generalities—and all generalities are false.

In the design of a complete radio receiver, after the price has been decided upon, the question of average sensitivity holds sway. Once this is decided upon, the selectivity becomes of importance. Here are two conflicting weights—one, i.e., interference, pulling toward sharp resonance; the other, quality, demanding comparative broadness. As high audio frequencies bolster up the intelligibility of the output of the receiver, it would seem important to guard them well in their passage through the radio frequency system. The public, however, demands super-selectivity, so the engineer eventually hits a more or less happy medium. He has thereby completed the most difficult part of the design.

Next comes the detector. Having now a specified gain through the radio frequency unit, the primary demands of the detector are automatically presented—and as automatically overcome. Actual distortion is often, in fact usually, introduced in this unit. Due to the fact that a detector works on a square law, and (*Continued on page* 1056)



One radio receiver manufacturer has incorporated a visual tuning meter in some models to enable users to tune their sets more efficiently. The insert shows the visual tuning device, while the circuit shows where it is employed. To the right is illustrated the receiver utilizing this new aid to good quality reproduction

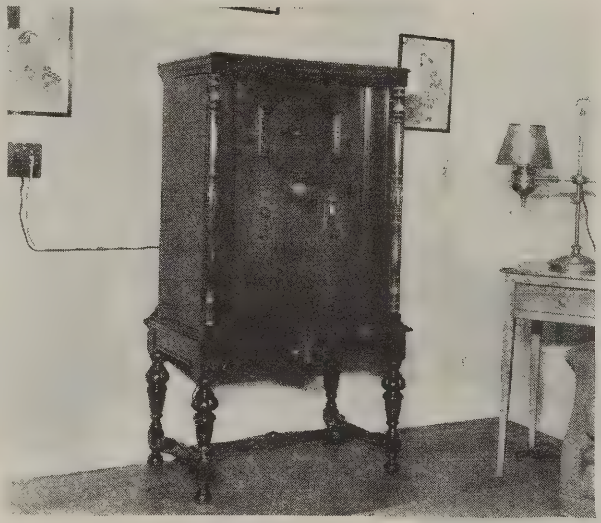
“Radio in

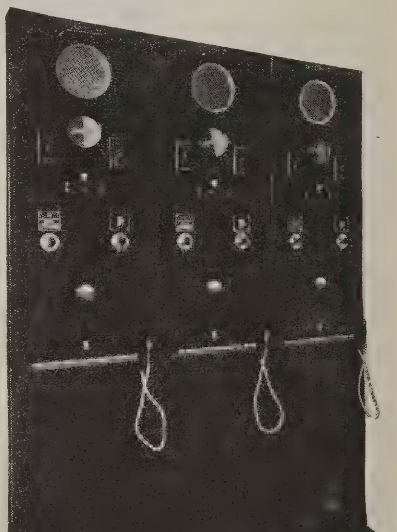
Hotels and Apartments to the Need for Installing Loud

By S.

A typical apartment house installation

WITH so many homes equipped with radio receivers, it would seem that our appetite for broadcast programs would be amply appeased at home. Yet hotel owners have found that radio-equipped rooms offer a strong appeal to the business man who is forced to be away from home; to the woman traveler, and to the many other classes that make up our hotel population. In reading the announcement of a new hotel opening nowadays, one quite expects to find the slogan "Radio in Every Room" and likely as not one will not be disappointed. Recently the New Yorker Hotel announced its opening in extensive advertising spreads in the newspapers, and in all this advertising one of the prominently featured attractions was radio in each of the 2,500 guest rooms.





(Above) Eighty individual receivers may be operated from a single outdoor antenna by means of a special coupling system. (Right) A three-channel amplifier system in the Plymouth Hotel, New York City. This includes automatic time switches which turn the power off and on at predetermined hours, thus eliminating the need for an operator

The movement to equip hotel rooms for radio reception probably gained its original momentum from the inauguration of radio service several years ago in all of the Statler Hotels. It is said that the entire installation cost $1,000,000 and was well worth the expenditure. At any rate, radio is still a feature of this chain of hostelries.

In the early days of radio broadcasting, hotels tried out various schemes to provide reception for their guests. One of the most popular earlier plans was that of keeping on hand a stock of portable receivers to operate from a "loop" antenna and of renting these to guests at a nominal fee. One Chicago hotel followed this plan and found that it offered such a strong appeal to guests that many wanted to purchase the receivers outright to take with them when they left. To meet this demand the hotel developed a selling scheme whereby any departing guest could purchase the receiver he had used, applying the rental he had paid toward its price. As a result a great many of these receivers were sold at a sufficient profit to make the plan worth while.

In general, however, the renting of individual receivers to guests was not entirely satisfactory because of the inconvenience of battery renewals and tube damage which resulted from careless manipulation of the receivers by the guests, and by the necessity for using a "loop" antenna, with its attendant difficulties in steel-framed hotels. Another drawback was the annoyance caused in neighboring rooms by loud speakers operating late at night.

The next step ahead was the adoption of a centrally installed receiver and amplifier with the output wired to headphones in each room. Headphones were still popular in those days, and were admirably adapted to hotel use because they could not disturb guests in adjoining rooms and required little power to operate—a decided advantage in view of the limited power-handling ability of the so-called "power" tubes of that day.

Naturally, as loud speakers were improved and came into general use in homes, hotel guests began to demand them in place of headphones. In the meantime larger power tubes had been placed on the market, and amplifiers became available to provide the increased power necessary in the operation of a large group of loud speakers. So from this beginning hotel radio was gradually worked up to the present-day state of near perfection, overcoming many obstacles which the casual visitor to a hotel little realizes.

The cost of an installation in a large hotel is no small item, particularly as a single central receiver and amplifier have not been found adequate, since such equipment permits the distribution of only a single program. Obviously no one program can satisfy all types of listeners, so the usual plan in hotels has been to provide from two to five program channels, thus making a corresponding number of programs available from which each guest may make his selection, but requiring one receiver and amplifier for each of these channels. A first-class hotel installation costs anywhere from $20 to $75 or more per room, de-

Every Room”

Everywhere are Awakening Modernization by Speakers in Every Room

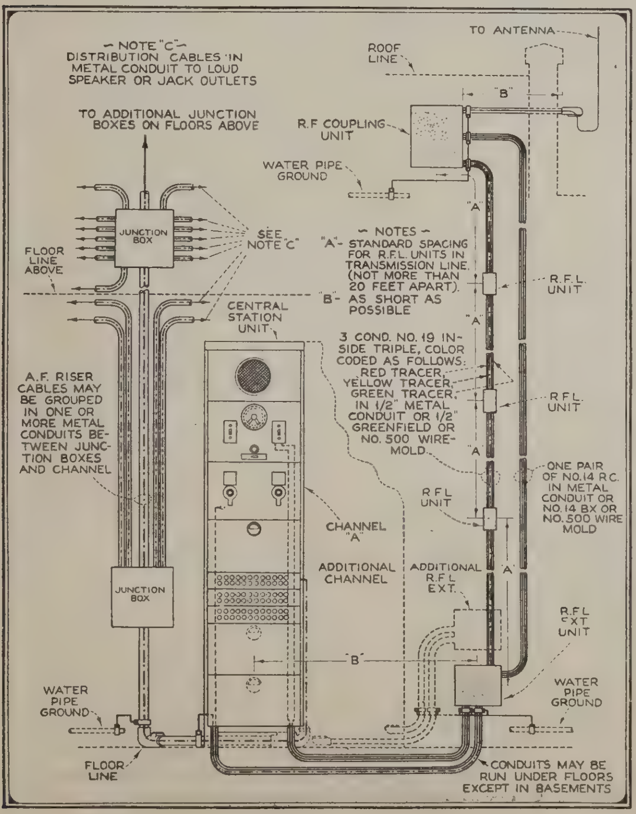
Gordon Taylor

Built-in magnetic speakers are fool-proof and inconspicuous. The volume control and program selector are within easy reach

pending upon the number of rooms, number of channels and quality of service.

In spite of the cost, more and more hotels are going in for radio, because time and again it has demonstrated its value in attracting guests. Obviously if the prospective guest has a choice between two hotels which are otherwise equally attractive, he will favor the one that offers the additional attraction of radio in his room. Realizing this, it is becoming quite customary for new hotels to be radio-equipped, since the hotel field is highly competitive, and a new hotel must include up-to-date refinements and conveniences to an outstanding degree, if it is to obtain its share of business.

One of Hotel Pennsylvania's dining-rooms in New York City which is equipped with loud speakers. In the photograph above the loud speaker is concealed behind a grille in the ceiling


TO ANTENNA
ROOF LINE
"B"
R.F COUPLING UNIT
WATER PIPE GROUND
"A"
— NOTE "C" — DISTRIBUTION CABLES IN METAL CONDUIT TO LOUD SPEAKER OR JACK OUTLETS
TO ADDITIONAL JUNCTION BOXES ON FLOORS ABOVE
JUNCTION BOX
SEE NOTE "C"
FLOOR LINE ABOVE
— NOTES —
"A"- STANDARD SPACING FOR R.F.L. UNITS IN TRANSMISSION LINE. (NOT MORE THAN 20 FEET APART).
"B"- AS SHORT AS POSSIBLE
R.F.L. UNIT
CENTRAL STATION UNIT
3 COND. NO. 19 INSIDE TRIPLE, COLOR CODED AS FOLLOWS: RED TRACER, YELLOW TRACER, GREEN TRACER, IN 1/2" METAL CONDUIT OR 1/2" GREENFIELD OR NO. 500 WIRE-MOLD.
A.F. RISER CABLES MAY BE GROUPED IN ONE OR MORE METAL CONDUITS BETWEEN JUNCTION BOXES AND CHANNEL
ONE PAIR OF NO.14 R.C. IN METAL CONDUIT OR NO.14 BX OR NO.500 WIRE MOLD
R.F.L. UNIT
CHANNEL "A"
ADDITIONAL CHANNEL
ADDITIONAL R.F.L. EXT.
R.F.L. EXT UNIT
JUNCTION BOX
WATER PIPE GROUND
FLOOR LINE
CONDUITS MAY BE RUN UNDER FLOORS EXCEPT IN BASEMENTS

The schematic layout of a typical power amplifier installation for hotels. At the left is shown a multiple antenna system which permits the operation of a large number of receivers from a single antenna

This same condition works the other way around also. That is, the new hotels with many added refinements dig into the business of existing hotels, with the result that slowly but surely the older hotels must be remodeled to provide some of the present-day refinements. Within the next few years many of the older hotels are going to find it necessary to install radio, and this will result in a tremendously increased field of operation for installation men and manufacturers of hotel radio equipment.

While on the subject of the field that hotels offer to the radio industry, it is interesting to note that an average of 770 new hotels are erected annually, costing on an average approximately $225,000 each for construction alone. This represents a potential market for radio equipment and installation amounting to over $3,000,000 annually, and this is in new hotel construction alone.

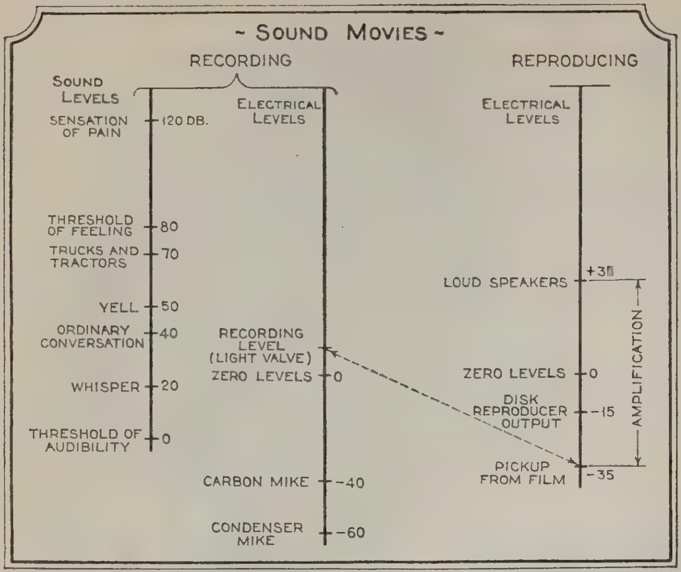
For every one of these new hotels there are approximately 35 already existing hotels. That is, in a survey made early in 1928, there were shown to be 26,000 hotels in the United States. Many of these, of course, will never be radio equipped. but many, on the other hand, are "live prospects," which in the aggregate represent a tremendous potential market that has as yet scarcely been touched. Obviously there are tremendous opportunities here for the development of radio business, much of which is simply awaiting more aggressive sales and promotional activities on the part of those who have service or equipment to sell.

Modern hotel radio equipment (*Continued on page* 1057)

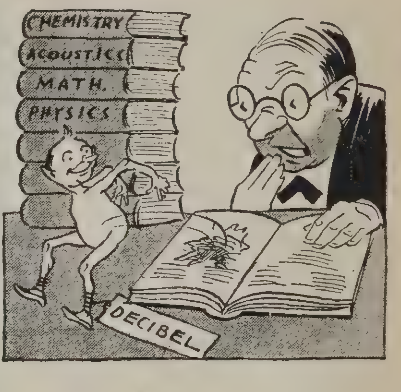
Behold!

What It Is, What It and Something

By C.



The chart above shows the values of sound, indicated in decibels, dealt with in the sound movie field. In the recording end two scales show the relative values of sound against microphone pick-up, while the reproducing scale indicates the electrical values of sound obtainable from audio units



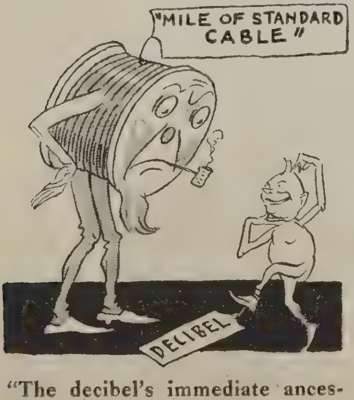
"The radio engineer has constantly increased his vocabulary with terms borrowed from the realms of physics and other branches of science"

NOT content with surrounding the infant industry with a haze of technical phraseology sufficient to impress all common folk with the dignity and awesomeness of his profession, the radio engineer has constantly increased his vocabulary with terms borrowed from the realms of physics and other branches of science. Out of the depths of these esoteric mysteries has recently come a new word, baffling to the layman, ear-tickling yet puzzling to the practical radio man: the "decibel." To penetrate the mysteries of the decibel, and to lay bare before the very eyes of the palpitating reader this perplexing product of science, is the purpose of this article.

Before perusing further, the reader is requested to accept the following fundamental conception: The decibel is a ratio. Nothing more or less. It is not sold by haberdashers, nor do doctors prescribe it as a tonic. It represents merely the relation between two quantities, whether of sound or of electrical energy.

> The decibel is a ratio. Nothing more nor less. It represents merely the relation between two quantities, whether of sound or of electrical energy

Another point: if we increase the amount of power in a circuit 100-fold, we raise the power level 20 decibels; if we increase it 1000-fold, we raise it 30 db; 10,000-fold, 40 db; 100,000-fold, 50 db; and so on. Each time we multiply the power by 10, we add 10 decibels to the power level. Thus this compact unit proves very useful when dealing, for example, with gain ratios of modern amplifiers, which when using screen grid tubes may yield overall amplifications (antenna to loud-speaker) of 100,000,000—a figure that can be expressed with a considerable saving of white paper as 80 db.



"The decibel's immediate ancestor was the 'mile of standard cable'"

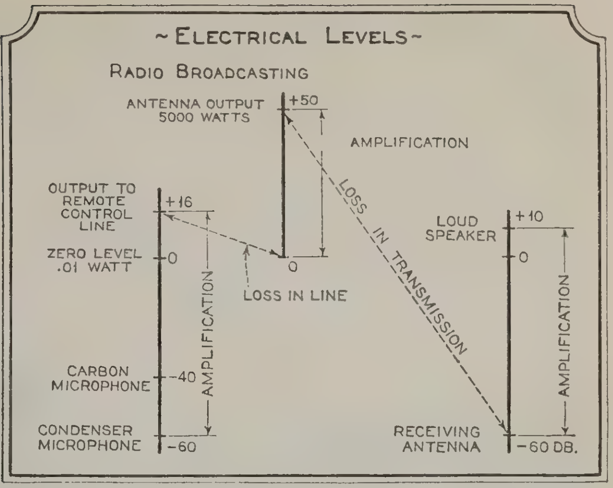
Unlike the pound, the foot, the inch, or the gram, the decibel has no counterpart in a concrete object. It is a wholly arbitrary standard, set up originally by telephone engineers for convenience in measuring efficiencies of telephone circuits. Its immediate ancestor was the "mile of standard cable," used to compare power losses or gains with those encountered in the "standard reference circuit." This latter consists of two common-battery telephone sets connected through transformers to a length of standard cable, which in practice was replaced by an artificial line representing the ordinary telephone cable, with a normal resistance of 88 ohms and a capacity of .054 microfarad per mile. If the input to such a circuit was increased, the amount of the increase could be measured in terms of the length of standard cable that had to be inserted in order to bring the output back to its previous level.

The greatest objection to the "mile of standard cable" as a unit for practical work was that a mile cable, having a certain amount of inductance and capacity, does not have a flat frequency characteristic; the transmission depends upon the frequency as well as the power. In dealing with different types of circuits, there was need for a new unit—one entirely "distortionless"; one based upon power, since gain or loss of power is the true measure of efficiency; one represented by a simple ratio, and somewhat comparable with the old standards. To find the over-all gain of a multi-stage amplifier, one must multiply together the individual gains—a clumsy operation, especially where the product runs well into the millions. For this reason, it was decided to make the new unit logarithmic, since numbers may be multiplied simply by adding their logarithms, and with a logarithmic unit as standard,, over-all gains could be expressed as the sum of the individual gains. Moreover, the ear hears not uniformly according to the intensity of sound, but upon a logarithmic scale, and such a unit would be useful also in sound work because it gives an accurate picture of our true auditory reactions. It was for these reasons that telephone engineers adopted a new standard, which they called the transmission unit—abbreviated "TU." An international convention later changed the name of the unit to "decibel," in commemoration of the work of Alexander Graham Bell. As it happens, one decibel is about

the Decibel

Means, How It Is Used About Its Origin

Sterling Gleason



Here are indicated the sound levels in decibels of the microphone output, speech amplifier, broadcast transmitter and the radio receiving system

HERE I AM
20
40
50

"Common sound levels range from the whisper at 20 decibels, to ordinary conversation at 40 and a yell at 50"

the smallest change in sound intensity that can be detected by the ear, and the term is sometimes called "sensation unit" by acousticians. Thus the three abbreviations, db for decibel, TU for transmission unit, and su for sensation unit, stood for one and the same thing.

"One decibel is about the smallest change in the sound intensity that can be detected by the ear"

As an expression of a ratio of one amount of power to another, the decibel is measured by the formula: $10 \log_{10} P_1/P_2$. That is, the number of decibels' gain or loss is found by multiplying ten by the common logarithm of the numerical ratio of any two amounts of power. For voltages or amplitudes, or currents, the logarithm of the ratio is multiplied by twenty instead of ten, since power is proportional to current squared or voltage squared, and twice the logarithm of a number squares the number. The latter formula holds true in the electrical meaning only for constant impedance. Where transfer of energy involves a change of impedance or of phase, various corrections must be applied. For an excellent discussion of these adjustments, the reader is referred to an article by John D. Crawford in the October, 1929, "Experimenter," a publication issued monthly by the General Radio Company.

For the benefit of those whose memory of this branch of mathematics may be a bit hazy, we shall devote this paragraph to a quick, superficial review of logarithms. Now the common logarithm is merely a way of writing numbers in terms of ten raised to a certain power. Instead of writing ten, we write its exponent, which denotes the power to which ten has been raised. Thus one hundred is equal to ten to the second power (10^2), and the logarithm of one hundred is the exponent, 2. The logarithm of ten (10^1) is 1. If the number is less than ten, but greater than one, the logarithm will be some decimal part of one. In other words, the logarithm of a number is the exponent by which ten must be raised in order to equal the given number.

$10^2 = 100$; therefore, $\log 100 = 2$.
$10^3 = 1000$; therefore, $\log 1000 = 3$.

Since ten is the base of this system, one can estimate a logarithm down to the nearest whole number, simply by counting the number of places between the first digit and the decimal point. Thus the number 869, having two places after the initial digit, 8, has a logarithm somewhat less than 3 (which is the logarithm of 1000), and 2 (10g 100)—the exact logarithm being two plus a decimal fraction. To find the logarithm accurately, one must consult a table of logarithms.

If you would like to be able to estimate gains or losses quickly in terms of decibels, you will find that the easiest way is to memorize the loss ratios corresponding to 1, 2, and 3 db. They are, respectively, 4/5, 2/3, and 1/2.

Question: If a loss of 3 db represents a loss of one-half, how much loss is 6 db?

Answer: Since adding logarithms multiplies the numbers they represent, adding 3 decibels' loss multiplies the 3-db loss by ½. Therefore a loss of 6 db represents two successive losses of 3 plus 3 db, or, ½ times ½=¼, which is to say that the power has been reduced to one-fourth its former value. Similarly, a loss of 9 db would reduce the power to ⅛, and so on—each additional loss of 3 db halving the power. A loss of 5 db is equal to successive losses of 3 plus 2 db, and therefore the power ratio is 2/ times 1/2, or 1/3.

To calculate gains, the easiest way is to find the ratio for the equivalent loss, then invert the fraction.

Question: What power ratio corresponds to a gain of 8 db?

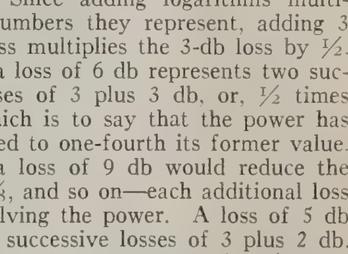
Answer: Eight equals 3 plus 2, and the loss ratios for 3 and 2 are respectively, 1/2 and 2/3. Multiplying ½ x ½ x 2/3 = 1/6.

Inverting, we have a given ratio of 6.

For numbers above 10, the process is simple also. *Problem*: What is the power ratio corresponding to 14 db? *Solution*: A 10-db loss represents a ratio of 1/10; d-db′ loss equals 2 plus 2 db, or 2/3 x 2/3. Therefore, a loss of 14 db equals losses of 10 plus 2 plus 2 db, or a ratio of 1/10 x 2/3 x 2/3 = 2/45. Inverting, we find the gain to be 45/2, or about 23 times. For 24 db., we would multiply the ratio by ten, giving a gain of 230; 34 db would represent a ratio of 2,300:1; 44 db, 23,000: 1; and so on.

The accompanying table, reproduced from the "Bell System Technical Journal," may assist in rapid computation.

(*Continued on page* 1051)



"The decibel is nothing more nor less than a ratio. It is not sold by haberdashers nor do doctors prescribe it as a tonic"

The High Road *to* Adventure

Radio Operating Aboard Ship Can Be the Ideal Stepping-Stone to Any of Many Interesting and Important Radio Posts. The Proof of the Pudding Is in the Eating—Here Is the Pudding

By Louis L. Credner*

THERE are boys and young men in every town, city and hamlet of the nation who are literally eating their hearts out because they were born too late. They believe all the romance and the opportunity for shining accomplishment have passed into history.

As a matter of fact, they have been born at just the right time to achieve their desires. They are the lads with the restless thoughts; the boys with the impelling urge to go places and do things. They are the young men in whose hearts live the same high courage and desires that sent the Vikings out on their raids and voyages of discovery; that enabled Christopher Columbus to lead his small fleet of three tiny vessels across the terrifying expanse of Atlantic waters; that centuries earlier made even the name of Attila the Hun a thing to be feared; that drove Marco Polo eastward to China and Paul of Tarsus westward to Rome; and in our own day has made Lindbergh the "Lone Eagle" and took Byrd and Wilkins to both the top and bottom of the globe.

Today, if these boys who are unwilling to confine their lives to the store, the office, the shop or the farm, really wish to live their adventures instead of just dreaming of them, they can do so. They have only to prove that they have the will to smash the shackles which bind them and then boldly hit the trail of their desires. Today you can go places and do things which were impossible in the old days, for the world is indeed moving forward. We have passed through the age of the many-oared galley and the foot traveler, the uncertain progress of the windjammer and the covered wagon, the swifter pace of the steamboat and the iron horse, the rush of the turbine-driven ship and electric locomotive, until now we annihilate distance by flying through the clouds in airplanes.

If you wish to travel the highroad of adventure and then tell the whole world of your exploits you can have your wish, and the good fairy who will make that wish come true is "Radio."

The road over which radio will lead you is a varied one, but always it is an interesting and profitable one. It may take you to unknown places or it may show you adventure in the midst of the largest and most crowded cities. No matter whether you desire to seek your fortune on the sea, in the air or

WEST SIDE Y.M.C.A. EDUCATIONAL DEPARTMENT
5 West 63d Street, New York City
Office of the Educational Director

Mr. Arthur H. Lynch, Editorial Director
Mackinnon-Fly Publications, Inc., 381 Fourth Avenue, N. Y.
Dear Mr. Lynch:

Our graduates, operating radio aboard ship, visit every port on earth. Our repair men are in every state of the Union, and also in many foreign lands. No period of radio history offers greater opportunities for youth than are now presented.

Any young man with the right mechanical aptitude, with normal good health and with a desire to specialize in radio work faces after graduation a field that is international in scope—a vast, active and young industry with its greatest years ahead of it—and a work that presents the widest conceivable latitude for all the service and inventive talent he may be able to give to it.

There are abundant jobs for mechanics—and also as many chances to get into business for themselves as any serious, industrious, studious, capable and ambitious young man would desire.

It is common sense that we all do best that which we like most to do. For young men who like radio the challenge is not to the opportunities, the challenge is to the young men themselves; to get busy and decide thoroughly to qualify themselves for the work they desire to do.

Sincerely,
Albert H. Eichholz.

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*Principal of the West Side Y. M. C. A. Radio Schools, New York City.

on land, you may have that desire fulfilled, for radio is needed everywhere. Wherever there is need of speed, wherever there is need of safety you will also find a real need for a radio, for radio is becoming a prime factor in safety on sea and land and in the air.

Where Opportunity Lies

Roughly speaking, the opportunities in radio are divided into three classes: the radio operator, the radio mechanic and inventor, and the radio executive. And each of the three classes has outlets in many fields.

For instance, the radio operator may be located on shipboard, sailing to all corners of the globe. Or, on the other hand, he may be in charge of a shore station, sending commercial messages or giving compass directions to those afloat. He may be stationed at a flying field, directing the movement of aircraft, or he may be aloft in the plane, with his safety depending upon receiving accurate forecasts of weather changes over the course he is traveling. He may be connected with a transcontinental railroad, in continual contact with all its trains, or in any one of the many phases of commercial broadcasting.

The radio mechanic may find his work in any of these places, for where there are operators there must always be mechanics as well. In addition he will go ahead of the announcers and photographers, to the scenes where history is being made, the big football games and prize fights, the political conventions and other important gatherings, and will be rushed by plane to the places where spot news of the day is happening so that the impatient public can receive the details.

For the inventor there is no limit as to what he may do, for the seemingly impossible of today is rapidly becoming the commonplace of tomorrow.

And if any think the financial return is not great enough to challenge the most ambitious, let him consider the possibilities of the radio executives, the men who will control all the various phases of radio in connection with aviation, rail transportation, commercial message companies, broadcasting, news service, architecture, amusement enterprises, the automobile, the motorboat, police departments and many lines of big business. In fact, the end of the trail is not in sight.

As an example, radio sets in automobiles, instead of being just a fad, as some may have believed, are already being adopted by General Motors, Chrysler and Dodge among the manufacturers and equipment for other makes is being made by Delco-Remy, American Bosch and Transitone, National, Silver-Marshall and many others.

At the present time several aviation transportation companies are looking for men competent to design and supervise all the necessary sending and receiving equipment for their lines, and also the personnel needed to operate it. The opportunities in radio are not of the past, nor yet of the future. They are here right now.

Operating as a Start

If you select radio operating for your start (and notice I say start, for operating often leads to rapid advancement in the mechanical and executive fields), you will find it a most interesting life. It will give you the opportunity of going to sea and visiting the strange places of the world, to talk from experience of gay Paris, far-off Hongkong, the beauties of a Mediterranean sunset, or the strange native customs in the islands which dot southern waters.

The radio operator is an officer and lives like all the other officers on board ship. He eats with them and is provided with officer's quarters, which are cared for by a special steward or cabin boy. All passenger ships carry two or more operators (the *Leviathan* has eight) and freighters usually carry one. On passenger ships a continuous radio watch is kept, while on freighters a watch is kept only during a few minutes of every hour during the day and early evening. The work is light, pleasant and interesting. When a ship is in port the operator is free to go ashore and do as he pleases. Some freight vessels remain in foreign ports for weeks at a time and the radio operators have splendid opportunities to make excursions inland. They also have plenty of time for studying, experimenting and preparing themselves for promotion.

While the bulk of the work of (*Continued on page* 1043)

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The Proof of the Pudding

The above photograph was made at a dinner recently held in New York City tendered to Rudolph L. Duncan, when he was made President of the R. C. A. Institutes. A great number of those who attended are successful in the radio industry and were formerly radio operators. Some of them are as follows:

1. Capt. R. H. Ranger, Photo-Radio Engineer R. C. A.; 2. A. A. Isbell, Manager, Commercial Department R. C. A. Communications; 3. C. B. Cooper, Radio Manufacturers' Representative; 4. V. Ford Greaves, Radio Sales, Fellow I.R.E.; 5. Gano Dunn, President J. G. White Engineering Corporation; 6. Geo. H. Clark, Manager Exposition Division R. C. A.; 7. Rudolph L. Duncan, President R. C. A. Institutes, Inc.; 8. T. M. Stevens, General Supt. Radiomarine Corporation of America; 9. W. K. Wing, Editor Radio Broadcast; 10. J. M. Meacham, Vice President QRV Radio Society; 11. W. C. Cockitt, Manager, R. C. A. Communications Company; 12. Victor Kubanyi, President of a New York Real Estate Company; 13. Samuel Kay, Radio Instructor, R. C. A. Institutes; 14. Chas. E. Drew, Radio Instructor, R. C. A. Institutes; 15. W. S. Fitzpatrick, Assistant Manager, Exposition Division R. C. A.; 16. L. S. Manley, Manager Service Sales Division R. C. A.-Victor; 17. M. L. Margin, Representative Radiotron Division R. C. A.; 18. C. C. Levin, President Walthal Radio Company; 19. Austin Lescarboura, Radio Editor and writer—former Managing Editor Scientific American; 20. A. J. Costigan, Radio Traffic Supt. R. C. A.; 21. W. C. Campbell, Radio Representative R. C. A. Communications Company; 22. O. M. Black, Radio Instructor, R. C. A. Institutes; 23. F. R. Bristow, Vice President R. C. A. Institutes, Inc.; 24. F. H. Hazelbaker, Radio Traffic Supervisor R. C. A.; 25. J. A. Case, Radio Instructor, R. C. A. Institutes; 26. J. H. Dunham, President QRV Radio Service Company; 27. F. H. Horman, Radio Instructor, R. C. A. Institutes; 28. W. B. Miles, Radio Instructor, R. C. A. Institutes; 29. R. E. Bogardus, Radio Engineer, R. C. A. station at New Brunswick, N. J.; 30. Fred Muller, Traffic Chief, Tropical Radio Telegraph Company; 31. Charles Horn, Chief Engineer, National Broadcasting Company; 32. O. B. Hanson, Plant Engineer, National Broadcasting Company; 33. J. B. Schanz, Radio Instructor, R. C. A. Institutes; 34. R. G. Meisenheimer, Chief Operator, Broadcasting Station WABC; 35. J. W. Bayne, Radio Instructor, R. C. A. Institutes; 36. C. E. Pearce, Radio Instructor, R. C. A. Institutes; 37. Arthur Lynch, Editorial Director, Mackinnon-Fly Publications, Inc.; 38. C. J. Van Horn, Supt. Philadelphia Wireless School; 39. C. Peterson, Radio School Supt. Newark R. C. A. Institutes; 40. L. W. Sinclair, Radio School Supt. Southern Radio Institute; 41. H. H. Kiss, Radio Instructor, Philadelphia Wireless School, Baltimore; 42 P. W. Pratt, Radio School Supt. Eastern Radio Institute, Boston; 43. A. B. Burdick, Radio School Supt., New York, R. C. A. Institutes; 44. R. Burnette, Radio Representative; 45. F. Velton, Short Wave Engineer, New Brunswick, N. J.; 46. H. A. Sullivan, Comptroller R. C. A.; 47. A. A. Nicol, Assistant Treasurer, R. C. A.; 48. C. Shandy, Radio Inspector, New York City; 49. S. M. Fox, Radio Instructor, R. C. A. Institutes; 50. C. S. Anderson, Radio Editor R. C. A. Publications, The Wireless Age; 51. Ben Lazarus, Chief Engineer, Broadcasting Station WNYC; 52. J. H. Gregg, Asst. Supt. Radiomarine Corporation of America.

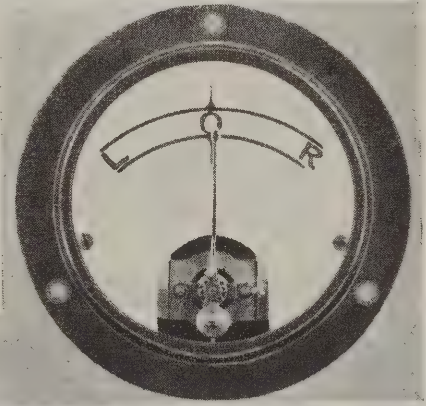
Flying by Radio Beacon

Being the Story of Some Recent Aircraft Radio Improvements by an Author Who Has Been Both Licensed Radio Man and Pilot for Many Years

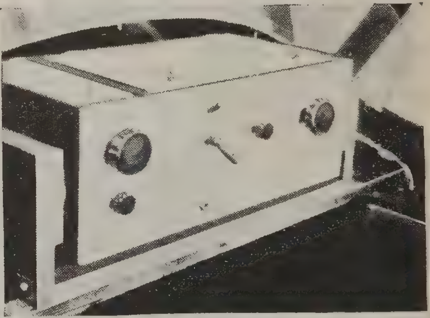
By Captain John R. Irwin*

Captain Irwin

WE welcome this opportunity to present Captain Irwin's articles to Radio News readers. During his very active career he has occupied many important posts, among which were Chief Radio Officer of the S. S. *Leviathan* and radio expert on Walter Wellman's ill-fated attempt to cross the Atlantic in an airship.



(Above) Aircraft compass indicating device. The needle pointing to "O" signifies that the airship is on her course. The needle deflecting to "L" or "R" indicates that the beacon upon which the pilot is steering is to the left or right, respectively.



(Above) Combination beam and radio compass receiver, beam receiver controls on the left and compass on the right. Beam indicating meter and compass visual course indicator are below to right

The fixed loop in the fuselage of a small biplane used in air tests

Radio News has followed aviation-radio developments closely, as previously published articles on this subject indicate. A list of them will be found on page 1060

RECENTLY we witnessed one of the leading industries of the United States undergoing a complete "house-cleaning." After we had been duly impressed with the splendid performance of Al Jolson in the pioneering "talkies," we observed with wonder the rapid change from silent pictures to the new type. We are told that it has brought new faces and new technique to the studios. But to those of us who have worked in the radio field for a decade or two, the new faces were not strange and the basic principles applied to the production of talking pictures, as far as sound effects were concerned, were nothing more nor less than the old stock in trade of our friends the radio engineers. If we were permitted to invade the strict privacy of a Hollywood studio while the production of a "million-dollar picture" was in process of development, the chances are that one of the sound technicians would be an old radio friend we had last seen on the waterfront adjusting the transmitter of an ocean liner, or handling a problem in his own garret laboratory or the workship of a radio manufacturer, and so it is coming to be with aircraft.

If you will consult the roster of the personnel of any large air transport company you will doubtless find the name of some radio friend. While the military branches of aeronautics always required that a certain number of radio engineers give thought to problems of communication, it is most recent that the strides of commercial aviation necessitated that radio provide adequate communication between airships and ground, as well as aids to navigation to supplement and even replace the ordinary methods.

It may well be said that it is as an aid to cross-country flying rather than a method of communication that radio will be called upon to play its most important part in air transportation. Desirable as it may be that the pilot of an airship be in communication with one of his bases throughout flight, especially that he may be able to receive frequent reports regarding weather conditions along his course, it is of far greater importance that he should be aided in maintaining a straight course toward his destination and, upon arriving in the vicinity of his goal, be guided in safety to the airport should the surrounding country be obscured, as it so often is, by fog or smoke.

Aeronautical navigation over land and sea presents greater difficulties than navigating a steamship over an ocean. At first thought, this would appear true as far as navigating an aircraft over a large expanse of water was concerned, but should not offer much difficulty in cross-country flying where the visibility gained by high

(*Continued on page* 1058)

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*Air Corps Reserve, U. S. Army.

A Modern Miracle

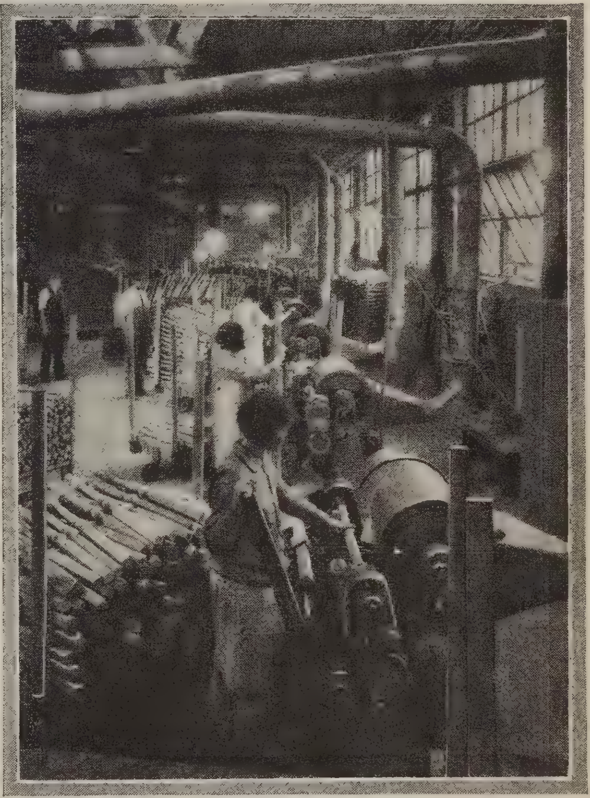
Majestic Did a $70,000,000 Business Last Year with a Daily Production of 5,000 Complete Receivers

ROMANCE — speed — and more speed — fancies made facts almost overnight. A $5,000,000 business in 1927, $40,000,000 in 1928 and $70,000,000 in 1929. Expansion in production so rapid as to take one's breath away. Such is an impressionistic picture of what goes on in the plant of Grigsby-Grunow Company, Chicago, manufacturers of the Majestic radio.

The remarkable things this concern has done, and is doing, can be epitomized in a sentence. Each day materials for one day's production are received at the front door, and each night the day's production is on its way to thousands of dealers. Not a square foot of storage for finished sets. Every month's production is increasing and it is now assured that the Grigsby-Grunow Company, by September 1, 1930, will be producing 7,000 sets daily.

Specific policies and methods have been followed in stepping the production up to 5,000 radio sets—over three-quarter million dollars' worth—per day in the plants of a seven-year-old radio parts manufacturing company that a year and a half ago had never made a complete radio set in its corporate life. This story is not about radio manufacturing. Instead, its subject is: Speedy Industrial Expansion.

Steady mass production, evidently (*Continued on page* 1037)

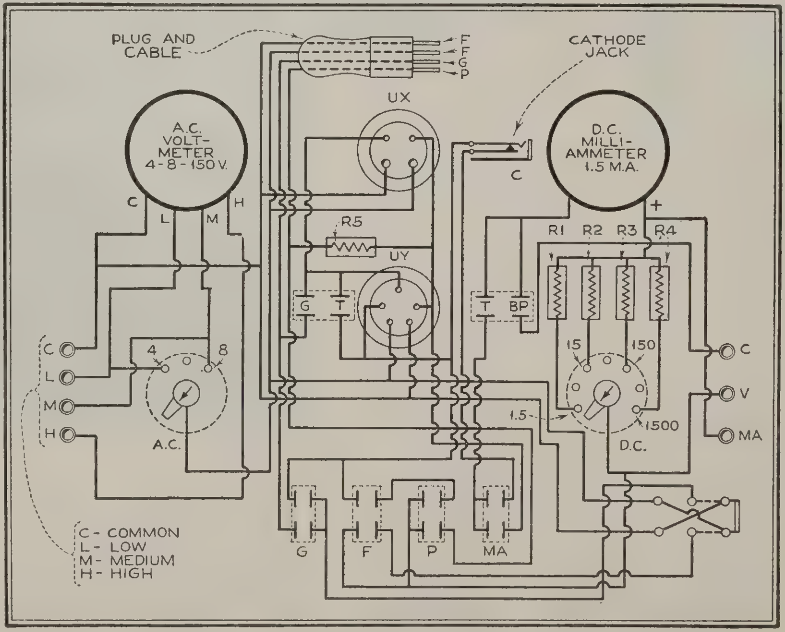


(Top) Chassis assembly lines in the Grigsby-Grunow factory. (Above) Machines operated by girls turn out 20,000 cabinet legs each working day. (Below, left) Final assembly in the cabinet factory said to be the largest furniture plant in the world. (Below) Coil-winding machines consume a large portion of the 60,000 miles of wire which goes into each day's production

A Set Tester De Luxe

IN no other profession is time as readily measured in dollars and cents as it is with the radio serviceman. If he is properly equipped with testing apparatus he can completely analyze a radio installation, and localize the difficulty in a few minutes. Too many of us try to get along with a voltmeter and a screwdriver. This means a tedious searching process that impresses the owner of the set with the idea that we are only guessing, and his confidence is destroyed immediately. On the other hand, if we can localize the difficulty in a few minutes and fix it, the owner will feel that we are familiar with our work, and will have confidence in the results. A large amount of time is also saved in this way.

However, set analyzers cost money, and the man who is just starting on his career as a serviceman has little to spare. If he can construct his own analyzer, utilizing time that might otherwise be wasted, he can effect a substantial saving in the assembly of his initial equipment. No difficulty will be encountered in constructing a tester of this character, and no little advantage will be gained by being thoroughly familiar with just how it works. In this way, the man who "rolls his own" has an advantage over the man who simply purchases a commercial instrument and tries to memorize the various functions.



Pictorial diagram of the tester; the lay-out of the instrumetns is exactly in accordance with the position of the parts on the panel

In this article, the writer will describe such a tester. The outfit will do practically anything that any other instrument will do, and will cost about forty dollars to construct. The apparatus is mounted in a Corona portable typewriter case, purchased for three dollars, retail, but wide latitude may be used here, depending upon what the constructor has handy. However, obtain the case first, and cut the panel to fit; do not attempt to buy a case to fit after constructing the instrument.

The only unusual parts used are the switches. They are available from a number of manufacturers and the ones used here are H. & H., having four contacts with a tumbler that closes the two upper contacts when the lever is thrown up, and the two lower contacts when the lever is thrown down. Six of these switches are used, as may be seen by referring to the wiring diagram. The rest of the parts are all standard, and will be described as we come to them.

Let us start with the d.c. voltmeter. This is a Weston 1.5 milliammeter, with appropriate series resistors to make four voltmeter scales. For the 1.5-volt scale, use a thousand ohms in series with the meter. This is R1 on the wiring diagram. R2 is ten thousand ohms, and gives a scale reading of 15 volts. R3 and R4 are one hundred thousand and one megohm, and give scale readings of 150 and 1500 volts respectively. These values were chosen because they are even multiples of the original scale, each being ten times the previous one, and making the voltmeter easy to read on all scales. The selector switch is a Yaxley nine-point switch, using alternate contacts so that the arm cannot short two points.

The a.c. meter is a Weston three-scale meter, a standard item; a.c. filament readings may be got by placing the selector switch on the proper point for the tube under test. The leads from this meter are brought out to pin jacks on the left side of the panel so that it may be used with leads at any time.

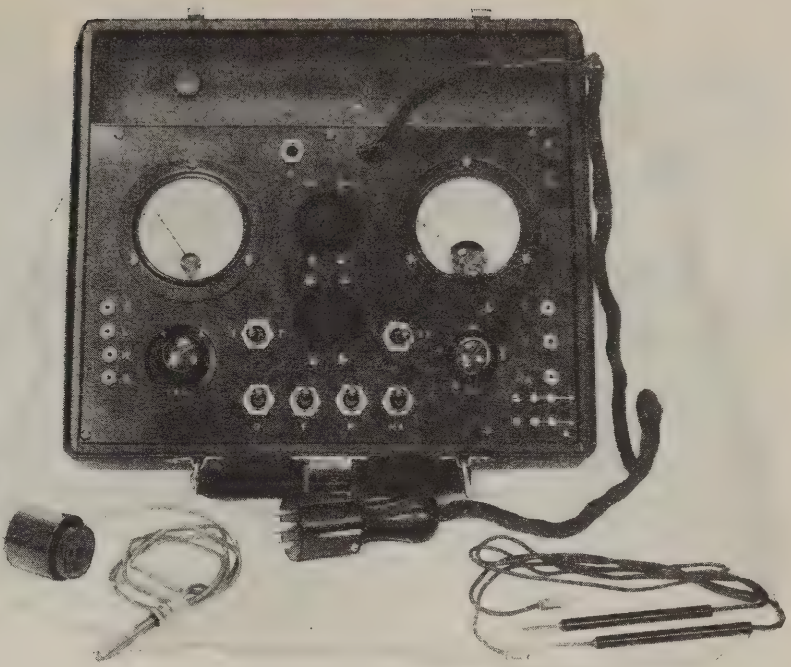
The sockets may be any type that readily lend themselves to panel mounting. The resistances used are Super Acraohms, obtainable from Shallcross Mfg. Co., Collingdale, Pa., and their values are all given above with the exception of R5, which is 100 ohms. The double-pole, double-throw switch is a Marco item, and is used to reverse the voltmeter in case the filament wiring is reversed, as it is in some instances. On a.c. sets it makes no difference on which side this switch is thrown.

The switch marked "T" and "B.P.," seen just to the right of the sockets, connects the voltmeter either to the tester proper or to the pin jacks on the right-hand side of the instrument. This switch is not an absolute necessity, but its use prevents the pin jacks from being "alive" when the tester is connected to a set. No such switch is used on the a.c. meter, since no such objection arises.

The wiring on the four switches for grid, filament and plate voltages, and plate milliamperes may at first seem somewhat complicated. However, a little study of the wiring diagram is in order here. Taking the negative filament as a reference

How to Build and Use An Instrument of Indispensable Value to the Experimenter and Serviceman

By G. E. Fleming*



Front view of the set tester showing the tester leads, the connecting plug and the adapter used when five-prong tubes are to be tested

point, the grid will be more negative than this point, and the plate more positive, which means that in one instance the positive side of the voltmeter must be connected to the filament, and the negative side to the grid. In the next instance, the negative side of the voltmeter will be connected to the filament and the positive side to the plate. A little study of the diagram will make this much clearer than a prolonged explanation.

The only point that is liable to cause any confusion is in obtaining the plate milliamperes. Anyone who has attempted to make shunts for a meter in fractional parts of an ohm knows that this is practically impossible. To avoid this contingency let us measure the drop across a 100-ohm resistance in the plate circuit of the tube. Since this test logically follows a plate voltage reading, let us leave the "P" switch down, and then throw the "MA" switch down. This disconnects the negative of the meter from the filament, and connects it to the low side of the resistance. Reading on the voltmeter scale, we read the voltage drop across this resistance. A little study of Ohm's law shows us that for each milliampere flowing through a 100-ohm resistance, the voltage drop will be 0.1 volts. Therefore the plate current of the tube will be ten times the voltage reading. In other words, the 1.5 voltage scale becomes the 15-milliampere scale, and the 15-volt scale will be 150 milliamperes. This may seem a little confusing when written, but in the use of the instrument it will cause no difficulty.

The jack shown is of the closed-circuit variety, and is used when five-prong tubes are to be tested. An adapter, as shown in Fig. 2, is made up, with the cathode lead brought to the tip of an ordinary phone plug. With the adapter in use this plug is inserted in the jack, which automatically makes the cathode the point of reference for all readings.

The switch to the left of the sockets is for the grid test. In the "G" position, the grid is connected in the normal manner, with whatever bias there is on the tube. The throwing of this switch to the "T," or test, position, disconnects the grid and returns it to the cathode or negative filament, as the case may be. This will give an increase in plate milliamperes that approximates the mutual conductance of the tube, which is the measure of worth of that particular tube. A table could be drawn up giving the approximate changes for various tubes, but it would be better for the new user to test several tubes known to be good, of each type, in order to learn just what changes occur.

Every item has now been covered except the plug that connects the tester to the receiver. This may be a discarded tube base, the cable leads carefully soldered to the appropriate prongs. The cable may be a four-lead battery cable, if the filament leads are heavy enough to carry the large current of the filaments of a.c. tubes.

To use an instrument of this nature, remove a tube from the receiver and plug in the tester in the socket from which the tube was removed, first being sure that all the switches are at the "off" position. Insert the tube (*Continued on page* 1035)

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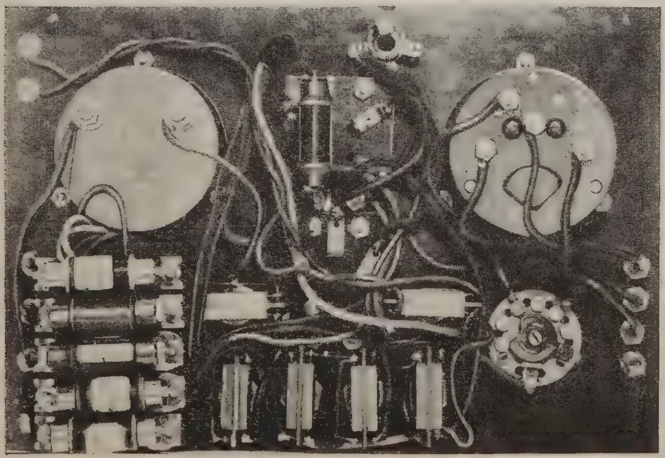
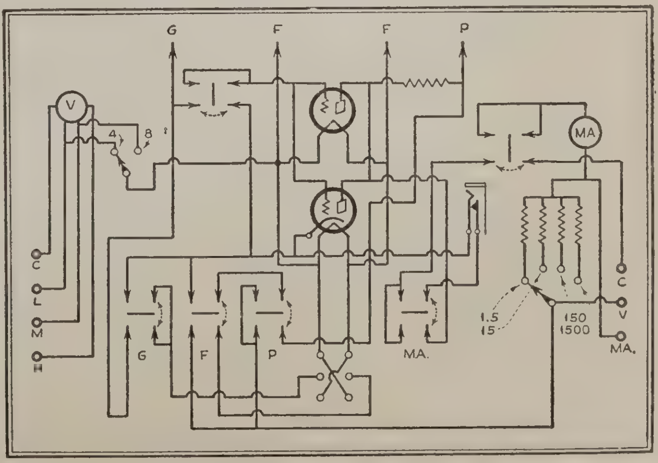
*Loftin-White Laboratories.

Rear view of the panel. The meters are shown on either side at the top. At the lower left may be seen the fixed resistors, while the six snap switches are clearly outlined in the center



A schematic circuit of the tester. This will prove valuable to the experimenter who wishes to substitute other parts for those specified in this article



BRICKBATS & BOUQUETS

Editor, Radio News, *Sir:* Big improvement in your magazine. I had figured on dropping it under the former régime.

Your March editorial, "The Broadcasting Goose," is by far the best article on this subject that I have read.

You describe exactly what we do, only that we have learned just when to cut them off.

One of our pet aversions is the list of cars, etc., on the General Motors hour.

Some have so much and such irritatingly obvious "bunk" that we have ceased to tune them in at all.

Lies and extravagant statements are boomerangs. The advertisers are, of course, necessary and a few know how to do it. The majority, however, are just kidding themselves when they work in too large a percentage of direct advertising.

Yours truly,
E. T. Birdsall.

Paterson, N. J.

Editor, Radio News, *Sir:* I wish to congratulate you on the splendid editorial which appears in March issue of Radio News and describes very adequately just what happens to the programs of those advertisers which consist in the main of the specific merits of their respective products.

The same applies to those stations, such as the local in my city, which resorts to use of records which can be purchased in the music stores for the portion of their entertainment program. The average radio listeners today wish to hear the human equation and the result is that the dealer who advertises through such a medium has simply thrown his money away, because the majority of the listeners in his local service area whom he is trying to reach will turn the dial to another program.

This situation rapidly promotes animosity toward the small locals with those who have modern receivers.

Very truly yours,
Anthony Sonza.

New Bedford, Mass.

Editor, Radio News, *Sir:* Being a reader of Radio News for a number of years and at the present time a subscriber, I am going to send you a letter that is just opposite from the ones generally appearing in your publication. This refers to opportunities for an experienced serviceman. It seems that the radio schools are responsible for a few of the letters that I have read in your publication. Naturally, such letters would tend to enroll many new students who wanted to get some of the radio gold.

So here goes.

I have been in radio since 1909, commencing as an amateur in the State of New Jersey when coherers and home-made apparatus was necessary and leyden jars punctured. Am a graduate of the Navy Radio School, class of 1913, served eight years as a chief radio electrician in the U. S. Navy, and since the advent of broadcasting have had a good position with a New York concern in their service department. That is, the title was good, but the salary was $35 per week, with a responsibility of five servicemen in the field, and personally had to do all the repairs in the shop on every radio set made, or shall I say thrown together. Well, I came to the Golden West, but not like most folks, to linger in the balmy sunshine and then go back east broke. I came out here to work and make a success. I must say, I have never had to look long for work, in the service end of radio, as I have references that prove my ability in our profession, but as before, I have never seen the $500 per week job that the radio schools tell about in every radio magazine published.

Incidentally, I heard of the first-class commercial radio operators which came out last year. Well, I took the exam and I have a first-class commercial ticket, but who wants to work on board a ship for $70 to $100 per month, and you know that's what is paid men who are responsible for thousands of lives and millions of dollars' worth of property. Really, don't you think that if the demand was so great for radio trained men, the salaries paid such men would commensurate with the demand? But it does not—far from it.

Here's another angle. A radio serviceman must have a good test kit. Personally, I have the new Weston listed at $125. Surely he should be compensated in accordance with what he knows and I expect if this letter is published in your Radio News there will be a few who will say that I can't be efficient or I would be getting the big money in radio. All right, how many are, outside of the ones mentioned in the "Radio Schools' ads"?

A bricklayer gets $14 per day and he doesn't have to know Ohm's law or doesn't even have to know how to sign his pay check—his cross will do. How come? Here's my idea of what ought to be done by and for the radio serviceman.

Each large city should have a radio serviceman's club; we won't say union, as we want to be more in (the professional class) a meeting place where ideas can be swapped, where classes could be held and men who have the same interest at heart could gather together and tell of their findings in radio, and learn of the other fellows' discoveries, and in turn have an employment agency where the manufacturer, the distributor, the dealer could call for a serviceman and know that he was going to get a real honest-to-goodness serviceman, not a screwdriver-and-pliers technician. Such an organization could be run very nicely by the payment of a small monthly sum to hold a meeting room for radio men, who are not radio men on the side, but eat it, sleep it and dream it.

At the time of writing this letter I am service manager for a large department store, with lots of responsibility, but the compensation would surprise your school ad writers. Thinking it over, this letter better not be published, for I would not want to be the cause of you losing any of the school ads.

More power to your magazine. Make it read like a serviceman's Bible.

Very truly yours,
Jack E. Bourke.

Editor, Radio News, *Dear Sir:* I read with interest the article published in a recent issue of Radio News in regard to the so-called record for message handling aboard the S. S. *Berlin* on its maiden voyage across the Atlantic.

I presume this article was published as a short story by its author and did not go through the customary make-up by the editors of Radio News. However, allow me to state that a record for message handling was established in this respect during the year 1918 and to my knowledge has never been broken.

Perhaps you may recall the days of the late World War when the boys were coming back from France; the steady stream of transports, destroyers, battleships of every line, merchant ships, etc., loaded to capacity and over with the A. E. F., and how nearly every one of these boys had a message of cheer and good news to their loved ones.

Bar Harbor, Maine, was the principal point along the whole Atlantic coast for the exchange of private, commercial and government traffic between these homebound vessels. Station NBD was forced to capacity with three transmitters, one Arc and two spark sets, to clear traffic from the steady line of incoming westward and homeward-bound vessels.

All three of the transmitters at NBD were remote control, the transmitters located at a point eight miles distant at Seawall, Maine. The Arc was tuned at 2,400 meters and 3,200 meters. A 10 k.w. spark transmitter was operated on 1,800 meters (although it was adjustable be-

(*Continued on page 1064*)

Gilbert G. Brown

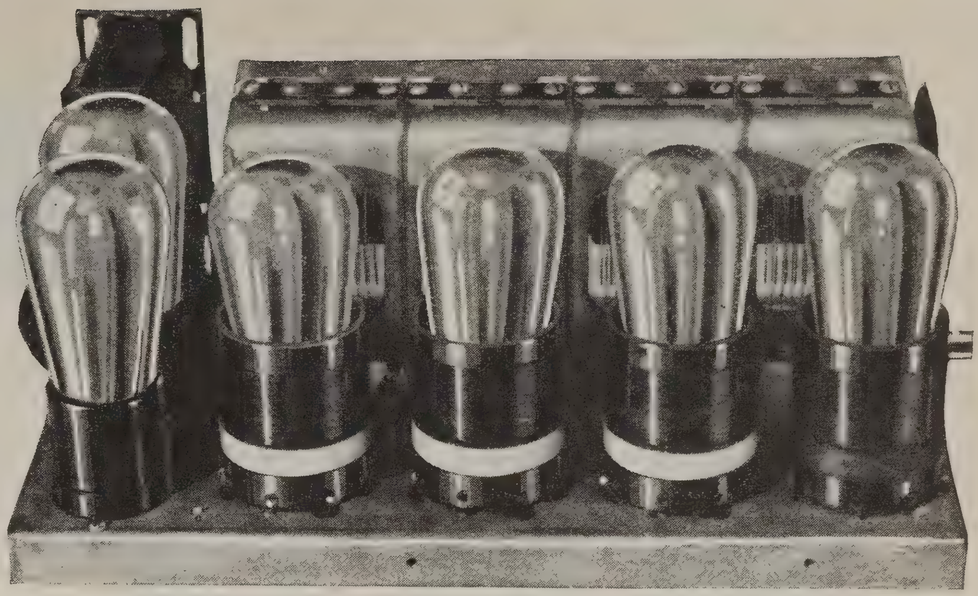


Fig. 2—In a car space is at a premium and therefore the auto-radio receiver is planned to occupy as little space as possible. Note how, in the receiver illustrated to the right, space has been conserved by mounting the tubes within the r.f. coils, a feature of design worked out by Mr. Brown

A Compact AUTO-RECEIVER

Here Are All the Constructional Details for a Successful New Car Receiver. The Novel Method of Mounting Coils and Tubes Is Only One of Many Which Make This Receiver Particularly Desirable for the Custom Set-Builder and Serviceman

By Gilbert G. Brown*

SPRING is again upon us and as our minds and cars turn to the open roads after being confined for the winter months, we find a new accessory to accompany us on our many spring and summer trips. This time it is in the form of a compact radio receiver especially designed to meet these requirements. The writer has spent several months in the laboratory designing and perfecting such a device, which has emerged finally in the form of a six-tube battery-operated receiver embodying various constructional and circuit features which lend themselves particularly to a receiver of this nature, and should be of special interest to the home set constructor.

Before delving into the circuit and constructional details, a chronological but brief description of the different circuits tested would seem to instill in the mind of the reader that the final circuit was not accepted as the ultimate, but rather because of its low cost and simplicity of construction. The first receiver perfected was a 7-tube receiver employing three stages of screen-grid radio-frequency, a power detector, one resistance-coupled stage using a screen-grid tube looking into a –71A push-pull stage, which in turn operated an electrodynamic type loud speaker. The sensitivity of this set was excellent, but the A and B battery consumption was prohibitive. Fading due to variable field strength was very pronounced on the open road. It was also found that ignition noise was very prominent due to the exceptionally high radio-frequency gain. Then, too, it was found that plenty of output for an average car was reached long before the power tubes began to be overloaded.

The next step was to drop one of the audio tubes and use a straight –71A circuit with the same plate potential applied. *i.e.* 180 volts. It was found that there was still more than ample volume before the power tube overloaded. The plate voltage was then dropped to 135 volts, which seemed to be the optimum value, and as overloading was at no time noticeable a great saving in B battery consumption naturally followed. The next step was to drop a stage of radio-frequency. Although this still left plenty of radio-frequency gain, selectivity was not up to a value desired by the writer and it was decided to go back to four tuned circuits.

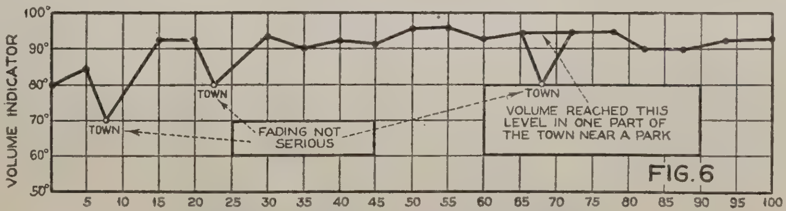


Fig. 6—The performance curve below illustrates the small amount of fading experienced in the operation of the auto-radio receiver designed by Mr. Brown on a test trip from Los Angeles due south for a distance of one hundred miles. In each case of severe fading it was noted that this phenomena occurred while in the vicinity of a town

Theoretical computations showed that if a receiver having three radio-frequency stages, at a gain per stage of 12, could be evolved, more than ample output could be assured when the field strength of the sta-

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*Chief Engineer, Autodyne Radio Company.

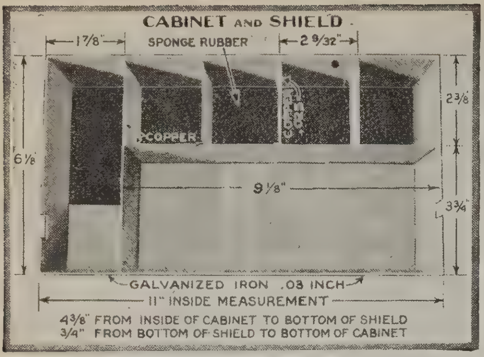
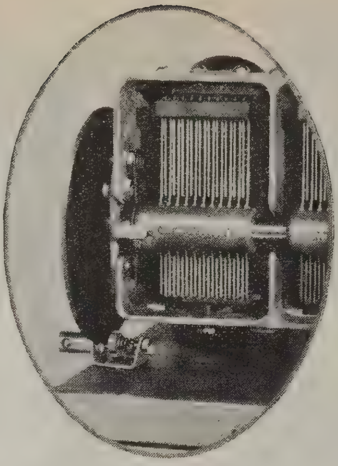

CABINET AND SHIELD
1⅞"
SPONGE RUBBER
2 9/32"
COPPER
6⅛
2⅜
9⅛"
3¾
GALVANIZED IRON .03 INCH
11" INSIDE MEASUREMENT
4⅜" FROM INSIDE OF CABINET TO BOTTOM OF SHIELD
¾" FROM BOTTOM OF SHIELD TO BOTTOM OF CABINET

Fig. 4—Specifications for building the metal receiver cabinet. In each of the compartments housing vacuum tubes the underside of the top of the shield can is lined with sponge rubber for tube protection and shock absorption



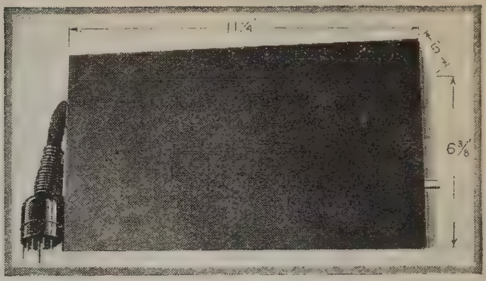


Fig. 1—The complete Brown auto-radio receiver in its metal can. The overall dimensions indicated attest to its compactness of design

Fig. 5 (Above to the left)—Further details, in picture form, showing the assembly of the tuning disk, drive and housing

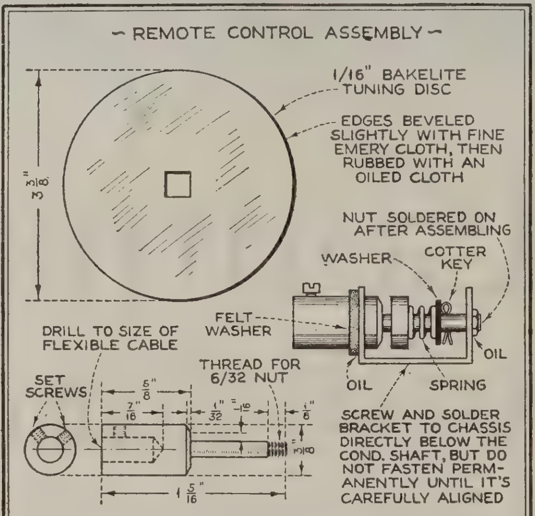

REMOTE CONTROL ASSEMBLY
1/16" BAKELITE TUNING DISC
EDGES BEVELED SLIGHTLY WITH FINE EMERY CLOTH, THEN RUBBED WITH AN OILED CLOTH
3⅜"
NUT SOLDERED ON AFTER ASSEMBLING
WASHER
COTTER KEY
FELT WASHER
OIL
OIL
SPRING
DRILL TO SIZE OF FLEXIBLE CABLE
THREAD FOR 6/32 NUT
SET SCREWS
5/8"
7/16"
1/32"
1/16"
1/8"
3/8"
1 5/16"
SCREW AND SOLDER BRACKET TO CHASSIS DIRECTLY BELOW THE COND. SHAFT, BUT DO NOT FASTEN PERMANENTLY UNTIL IT'S CAREFULLY ALIGNED

FIG.10

Fig. 10—Details showing the construction and assembly of the remote control, including the beveled disc, drive and bearing, for rotating the tuning condenser shaft

tion picked up did not drop to less than about 1½ microvolts per meter. It was further found that in a set with higher radio-frequency gain picking up a station of less than this field strength that the ratio of signal-to-noise level was so small as to render the music and speech unintelligible. Therefore a circuit having three stages of high-gain radio-frequency amplification, a plate-rectifying detector and two stages of audio-frequency amplification was the next experimental model; this receiver was fairly satisfactory, but as the power tube overloaded long before the detector circuit and as the writer wished to incorporate some device into the receiver which would give higher sensitivity on very weak signals without affecting the more powerful ones, the 200A detector was next given a tryout. It fulfilled these requirements very nicely and did not overload prior to the power tube. The addition of this detector circuit acted in no small degree as an automatic volume control due to its extreme efficiency on weak signals and comparative insensitivity on strong signals. The last-mentioned receiver is the one about to be described by the writer as, in his opinion, a satisfactory receiver for automobile use.

A few of the demands placed upon this receiver, and which incidentally it lives up to, are as follows: 1, low A battery consumption; 2, low B battery consumption; 3, high degree of selectivity; 4, high tone quality output; 5, minimum amount of interference from ignition noises; 6, minimum amount of fading; 7, simplicity of control; 8, simplicity of construction; 9, low initial and operating costs; 10, long tube life; 11, high degree of sensitivity; 12 easy mounting in any car.

A word regarding the selection of a loud speaker, one of the electrodynamic type seems to be out of the question, as sufficient baffling is not easy to obtain and its current consumption for field excitation is also a serious handicap. It would therefore seem that a high quality magnetic speaker capable of standing the d.c. component from the power tube or an inductor type dynamic would offer a solution. The inductor type dynamic proved to be a very successful speaker and is used by the writer in his own car. In this particular installation a hole was drilled through the dash and the speaker was mounted against a ring of sponge rubber. This type of installation gives a fine baffle. The mounting of the speaker should be given considerable thought, otherwise resonance from the loose parts of the dash will be objectionable. A good installation would consist of the speaker chosen being mounted in a cabinet made of plywood of the smallest size into which the speaker can be placed. The opening should then be covered with grille cloth, obtainable at any dry goods store. The covering can be glued over the aperture, then a protection device made of heavy wire in the form of a circle and covered with fine mesh metal hardware cloth which should be soldered to the ring. This, in turn, can be screwed to the face of the cabinet. The rear of the cabinet should be closed, so as to be made dust-proof, with a piece of speaker grille cloth. Do not close with wood or chamber resonance will result. If the back of the cabinet is placed close to the dash it might prove advisable to place a thin piece

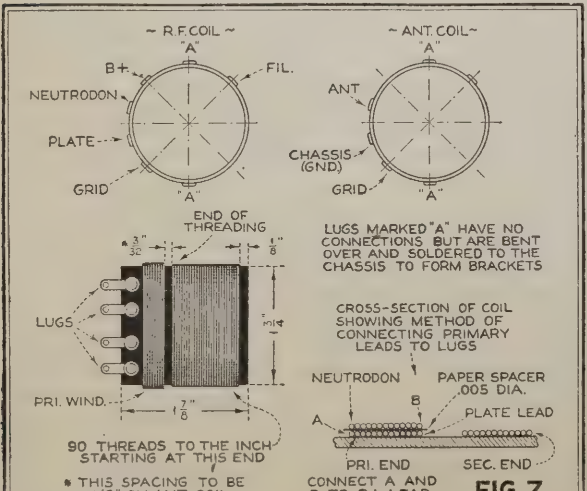

R.F. COIL
"A"
B+
FIL.
NEUTRODON
PLATE
GRID
"A"
ANT. COIL
"A"
ANT
CHASSIS (GND.)
GRID
"A"
END OF THREADING
* 3/32"
1/8"
LUGS
3/4"
PRI. WIND.
1 7/8"
90 THREADS TO THE INCH STARTING AT THIS END
* THIS SPACING TO BE 1/8" ON ANT. COIL
LUGS MARKED "A" HAVE NO CONNECTIONS BUT ARE BENT OVER AND SOLDERED TO THE CHASSIS TO FORM BRACKETS
CROSS-SECTION OF COIL SHOWING METHOD OF CONNECTING PRIMARY LEADS TO LUGS
NEUTRODON
PAPER SPACER .005 DIA.
B
A
PLATE LEAD
PRI. END
SEC. END
CONNECT A AND B TO B+ LEAD

FIG.7

Fig. 7 (To the left)—For those who wish to wind their own coils these specifications will prove helpful. Lugs are used for terminals and coil mounts

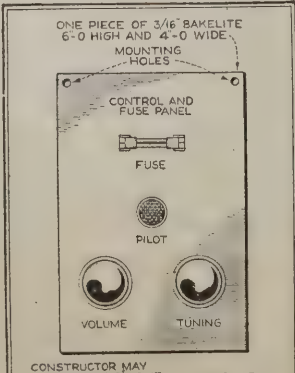

ONE PIECE OF 3/16" BAKELITE 6"-0 HIGH AND 4"-0 WIDE
MOUNTING HOLES
CONTROL AND FUSE PANEL
FUSE
PILOT
VOLUME
TUNING
CONSTRUCTOR MAY PLACE PARTS TO SUIT OWN REQUIREMENTS

FIG. 8

Fig. 8—A suitable control panel may be fashioned according to the layout given to the left. When completed it may be mounted on the dash within reach of the operator

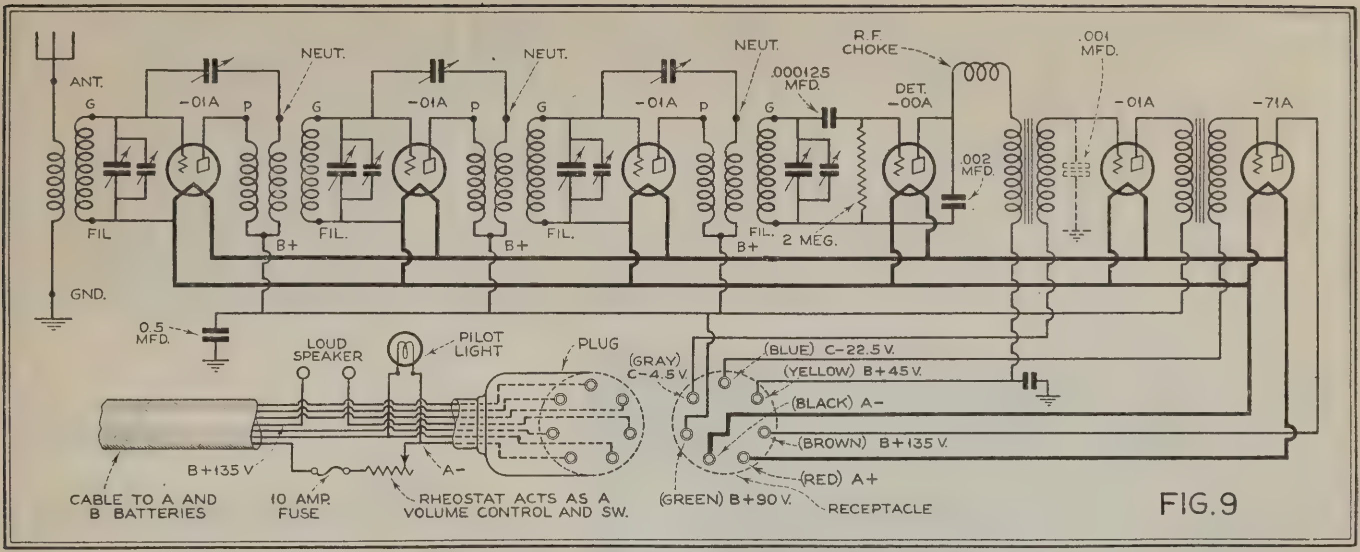

ANT.
GND.
G
P
-01A
NEUT.
FIL
FIL.
B+
NEUT.
R.F. CHOKE
.001 MFD.
.000125 MFD.
DET. -00A
.002 MFD.
-01A
-71A
2 MEG.
0.5 MFD.
LOUD SPEAKER
PILOT LIGHT
PLUG
(GRAY) C-4.5 V.
(BLUE) C-22.5 V.
(YELLOW) B+45 V.
(BLACK) A-
(BROWN) B+135 V.
(RED) A+
(GREEN) B+90 V.
RECEPTACLE
B+135 V
A-
CABLE TO A AND B BATTERIES
10 AMP. FUSE
RHEOSTAT ACTS AS A VOLUME CONTROL AND SW.
FIG. 9

Fig. 9—Full circuit details of the Brown auto-radio receiver are given above. Note that the connector cable must be opened up and the volume control, pilot light and loud speaker terminals inserted

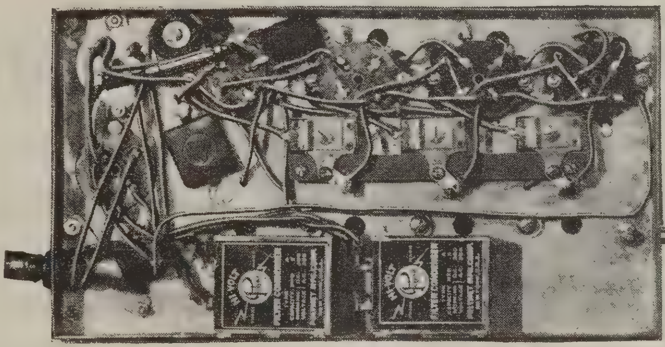


Fig. 3—An underside view of the receiver shows that much of the wiring is done here. Also, in the recess provided by the raised base of the chassis is located such pieces of equipment as by-pass condensers, neutrodons, choke coil, sockets, etc.

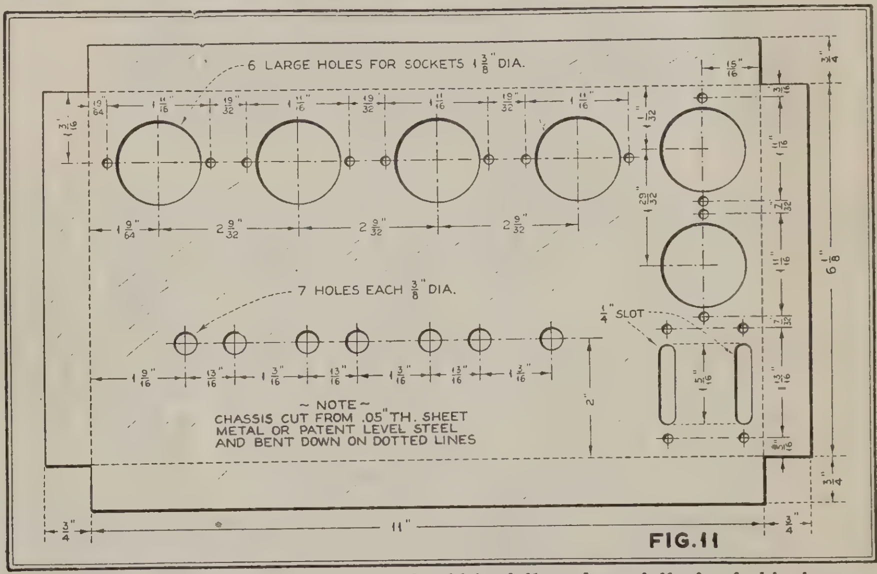

6 LARGE HOLES FOR SOCKETS 1 3/8" DIA.
7 HOLES EACH 3/8" DIA.
1/4" SLOT
~ NOTE ~
CHASSIS CUT FROM .05" TH. SHEET METAL OR PATENT LEVEL STEEL AND BENT DOWN ON DOTTED LINES
2 9/32"
6 1/8"
11"
3/4"
2"
FIG. 11

Fig. 11—The layout given below should be followed carefully for fashioning and drilling the chassis of the auto-radio receiver

of felt against the dash directly in back of the speaker cabinet to stop reflection of high frequencies. In no case should you have the speaker back closer than about three inches from the dash, a greater distance being desirable. The upholstery of the car absorbs a considerable amount of the high frequencies and this has been adequately compensated for by selection of transformers and placing the leads to the transformer so as to obtain some audio-frequency regeneration. If this regeneration should be sufficient to cause audio oscillation, use the smallest fixed condenser in the position noted by the dotted lines in Fig. 9. This capacity will be .001 mfd. or less.

The antenna system of the car will vary with the type and make of car; the finest aerial obtained with any particular car would be the largest piece of copper screen which could be placed in the roof of the car and which would not come closer than about three inches from the metal portion of the top. This is important, as the lowest capacity between aerial and chassis as is obtainable is desirable. The top and upholstery department of your local car dealer of your particular make of car should be able to install a very efficient aerial at a cost (depending on the type of body) ranging from $7.50 to $12.50. A piece of midget packard cable well soldered to the front left corner of the screen affords an excellent lead-in, as it can be placed beneath the metal or other parts of the windshield support, and due to its heavy insulation will not short and will have a very low capacity to ground. Copper screening is most desirable as an antenna, as wire placed in the roof will cause serious directional effects. This screening can be procured at your local hardware dealer at from eight to ten cents per square foot. If common fence wire is found in the upper structure of the top when the deck has been removed, it is very important that this be removed, as it is usually grounded and is of little use as an aerial even if not grounded. The screening should be stretched very tight and should be tacked in numerous places to the crossbows or rumbling will be noticed when driving at high speeds.

Much has been said in previous issues of RADIO NEWS regarding ignition noises, but a few words on this subject might be of interest. The usual installation consists of a twenty or thirty-thousand-ohm resistor of the carbon type (other types usually start arcing after being in use only a few days). A 3-watt resistor should suffice and this size is only necessary for mechanical stability. It should be placed in each of the spark plug leads at the spark plugs and one in the high-tension lead from the coil. A 1 mfd. condenser is placed across the generator, *i.e.*, from the hot lead where it runs into the cutout box to ground. It is important that it precede the cutout box so that it is always in the circuit. A .25 mfd. condenser should be grounded on one side (note, at a point at least six inches from the coil), otherwise you will be by-passing to a high-potential ground circuit; the other side should be connected to that primary lead on the coil giving (*Continued on page* 1040)

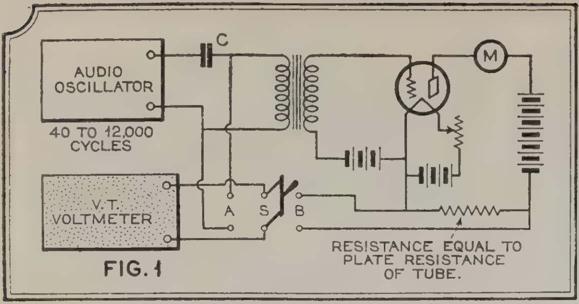


FIG. 1

FREQUENCY	INPUT VOLTS	OUTPUT VOLTS
25	2.0	40.5
50	2.0	53.1
65	2.0	56.2
100	2.0	59.1
150	2.0	61.7
300	2.0	62.9
ETC.	ETC.	ETC.

FIG. 2

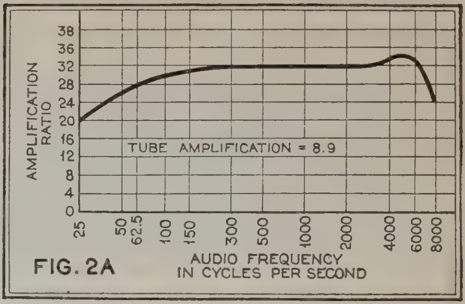
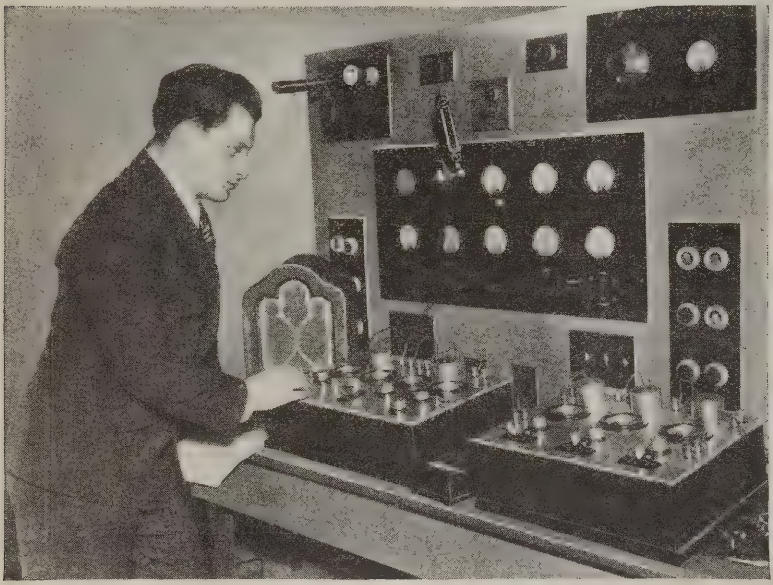


FIG. 2A



The author testing a loud speaker with his vacuum tube voltmeter. Fig. 1, the circuit employed to make a frequency run of a transformer. The throw-over switch permits comparisons between the audio oscillator voltage and the voltage delivered by the amplifier. Fig. 2—Voltage readings at the various frequencies at which the transformer was measured. In Fig. 2A these readings are shown plotted on logarithmic paper, producing a curve which shows at a glance the performance of the transformer over its entire range

Make Precision Tests *With a* Vacuum Tube

Progressive servicemen and
are finding the v.t. voltmeter
nosing radio receiver
vicing methods are both
Accurate, dependable
time and

By JOSEPH

LAST month we told the reader how a vacuum tube voltmeter and current amplifier could be built, and also explained the principle of its operation. It is the purpose of this present article to show how the above-mentioned apparatus can be used for all sorts of measurements.

Suppose, for example, we wanted to make what has become a very common measurement; that is, the frequency characteristic of a certain audio transformer. The purpose of the test is to determine just how this transformer performs at different frequencies. In this case it is not enough to say the transformer passes low frequencies, or the transformer passes high frequencies. What we want is a complete curve over the entire audible frequency range. In Fig. 1 is indicated the method for testing this transformer. A tube with a low internal grid-filament capacity is chosen, in order to make the test as much as possible a true indication of the transformer itself, without bringing any extraneous reactances into the circuit. The switch "S" is thrown to position "A," and an audio-frequency oscillator capable of generating frequencies over the entire range wanted (usually between 40 and 12,000 cycles) is coupled to the primary of the transformer under test, through a condenser "C." In order to make sure that the tube is not overloaded at any time, a milliammeter "M" should be inserted in the plate circuit of the tube as shown. The oscillator voltage should then be brought up to a value not quite high enough to cause a change in the reading of "M." This precaution is necessary because distortion in the tube itself will seriously affect the results. With the switch at "A" the voltage across the input to the transformer is measured on the vacuum-tube voltmeter, and by throwing the switch to "B" the output voltage is measured. Having made sure that all the apparatus is in working order and that the oscillator is at the lowest frequency value of the run, readings are taken with the switch at positions "A" and "B." The oscillator frequency is then raised and the voltage readings repeated. This procedure is repeated all through the frequency range wanted. Table 1 shows how some of these readings may appear. Since the human ear is a logarithmic device, the values received from the test should be plotted logarithmically. Such a curve for a well-known type of transformer is shown in Fig. 2. It is understood, of course, that the output voltage represents amplification furnished by the tube, but since it is also understood that the tube is not overloaded at any point, there is no reason why a curve of the type shown would not give us a true indication of the behavior of the transformer. It is perfectly possible, of course, to connect the secondary of the transformer to the voltmeter and receive thereby the true voltage amplification of the transformer. But the first method is the more useful since it takes in the behavior of the transformer in the type of circuit for which it was designed.

In very much the same manner we can determine the gain of a complete audio amplifier at different frequencies and under different loads by simply substituting the complete audio amplifier for the single transformer, and taking input and output voltage readings.

Most people seem to think that radio-frequency and audio-frequency amplification are horses of different color, although in fact they both behave in very much the same way. For this reason the gain can be measured in the same way. That is, voltage readings can be taken across "input" and "output" of any stage or any number of stages. The difference, in this case, lies in the type of oscillator. In measuring the gain of radio-frequency stages the signal source must also be at radio-frequency. This can very easily be done by the use of a radio-frequency oscillator of suitable type. In order to measure the gain of a stage of radio-frequency amplification, the circuit shown in Fig. 3 can be utilized. Care must be taken while

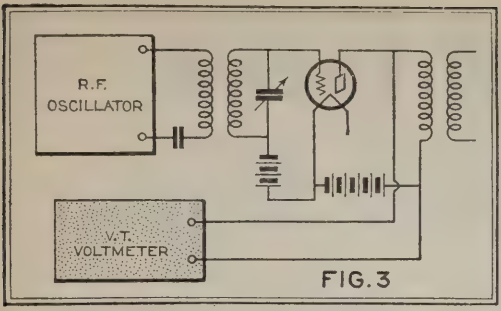


FIG. 3

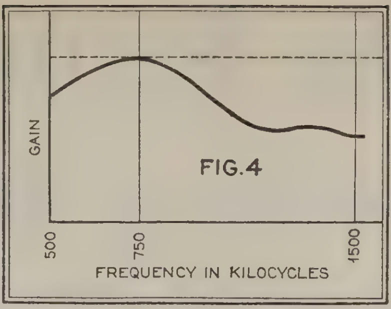


FIG. 4

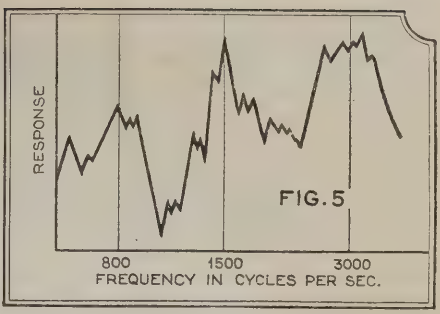
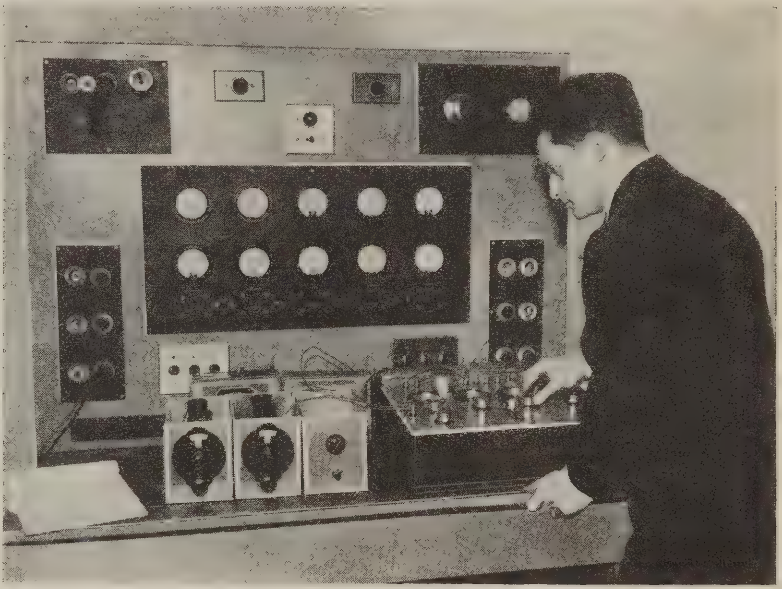


FIG. 5

Your
and Measurements
V*oltmeter*

experimenters everywhere of inestimable value in diag-ailments. Cut-and-try ser-expensive and inefficient. laboratory equipment saves money

I. HELLER*



Mr. Heller measuring the radio frequency gain of the S.W. Four receiver. Fig. 3—The circuit used for measuring the voltage step-up of a radio-frequency transformer. Fig 4—A curve illustrating the performance of a radio-frequency transformer. Note that the gain is particularly high at 750 kc. The dotted line indicates the theoretical curve of a perfect transformer, with equal gain over the entire frequency range. Erratic as it may appear, Fig. 5 shows the frequency response curve of a good loud speaker. We leave to your imagination the appearance of a curve of a not so good loud speaker

measuring at radio frequencies to make sure that the addition of the voltmeter has not brought the circuit out of resonance. Separate tuning condensers therefore should be used, and when the voltmeter has been inserted in the circuit, the tuning condenser should be readjusted to resonance. An example of the curve usually derived from such a measurement is shown in Fig. 4. The radio-frequency stage to which this curve applies is not a particularly good one, since the amplification at about 750 kilocycles is high, whereas the gain at other frequencies is considerably less. The ideal curve is shown by the dotted line in the figure.

In the broadcasting studio it is often a question as to whether or not sufficient sound is reaching the microphone. By the use of the vacuum tube voltmeter, fed by a microphone, it is possible to get an empirical sound value by means of meter readings. When such a test is being run over a range of frequencies, exact knowledge of the frequency characteristic of the microphone itself should be available. A microphone connected to the end of a long flexible cord can be moved around a room while an assistant takes voltage readings. In this way "echo spots" and "dead spots" can be found very easily.

One of the most important uses of the vacuum-tube voltmeter is the measurement of loud speaker characteristics. The writer remembers very well the days when audio frequencies and their distribution over the audible range was something no set or speaker manufacturer bothered his head about. The aim in practically every case was to secure volume, and if what came out of the speaker did not sound exactly the same as what went in, it was nothing to worry about. With the advent of the cone type of speaker and the availability of the power tube, frequency characteristics of loud speakers took on a sudden interest to the engineer and manufacturer. To the person who has never seen one, the loud speaker response curve is usually a revelation. Fig. 5 is a curve of a very fine type of loud speaker. One can imagine what the curve of one not so fine looks like.

There are several considerations entering into the testing of loud speakers other than those of apparatus alone. The type and size of room have an important bearing on the results, some experimenters having gone so far as to make their measurements in the middle of a large field. The angle at which measurements are taken is also very important and gives a series of curves of its own. These curves are called "zonal distribution" curves.

Going back to the measurements themselves, we can make an arrangement such as is shown in Fig. 6. The microphone is placed at some fixed distance from the speaker, and the speaker is excited by an audio oscillator and amplifier. The input voltage to the speaker is kept constant at some arbitrary value by means of a vacuum-tube voltmeter connected across the terminals of the speaker. The sound energy is impressed upon the microphone, and is fed into another voltmeter, or into the same one through a switching arrangement. The frequency is varied in equal steps (logarithmically) and while the voltage is kept constant at the speaker, voltage readings are taken through the microphone pick-up. The curve of Fig. 5 is obtained in this way.

The vacuum-tube voltmeter also comes in handy wherever a voltage level indicator is employed. It can be used to measure outputs of radio sets as well as voltages in any piece of apparatus. A voltmeter of this type can be permanently connected into the detector tube circuit as shown in Fig. 7. When connected in this manner it will indicate the presence of a radio station by a sharp deflection. If the meter is watched as the tuning control is turned the tuning can be brought up to the exact peak of the wave, where the best quality of reproduction is obtained.

(*Continued on page* 1063)

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*Chief Engineer, Wireless Egert Engineering Corporation.

The Junior RADIO Guild

The HOW and WHY of B-POWER UNITS

LESSON NUMBER TEN

BEGINNERS in radio often find that much of the information presented in technical journals is involved and "over their heads."

Yet, for those who have followed the radio art from the days when it was known as "wireless" these seemingly profound technical details are quite necessary.

So that the newcomers in radio might find data suited to their stage of advancement, every month RADIO NEWS has presented in its Junior Radio Guild department elementary information for the instruction of these beginners.

This month we discuss the B-Power Unit and how it works.

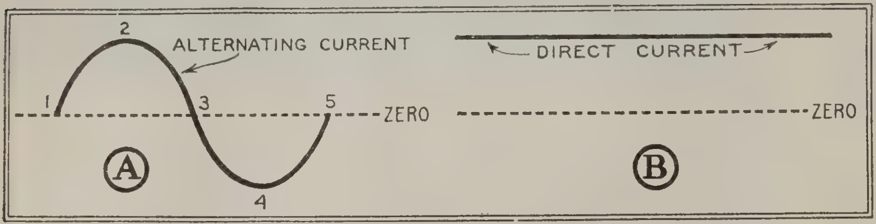


Fig. 1

IN this article we will attempt to explain what makes the wheels go round in a "B" power unit of the ordinary type used to supply plate voltage to a radio receiver. Perhaps the fact most commonly known about a "B" supply unit is that if the output terminals are touched while the "juice" is on one is apt to get a shock! This leads us to the first important point, which is, obviously, that a "B" power unit is a device which takes power from the house lighting circuit—since we have to put a plug into the light socket to make it operate—and supplies electric power to the receiver, as indicated by the fact that we got a shock. The electric power that comes out of a "B" power unit is not, however, the same in character as the power which it takes from the light socket. The current which is drawn from a "B" power unit to supply a set is called "direct current," for it always flows in one direction. On the other hand, the current supplied by the light socket is "alternating current." Now these two forms of current are not the same—in fact, they are widely different—and for this reason we must place between the light socket and our set a device which will function to change the alternating current supplied from the light socket into the direct current required by the radio receiver. We therefore have determined the reason for the use of a "B" power unit. Its primary function is to convert alternating current to direct current.

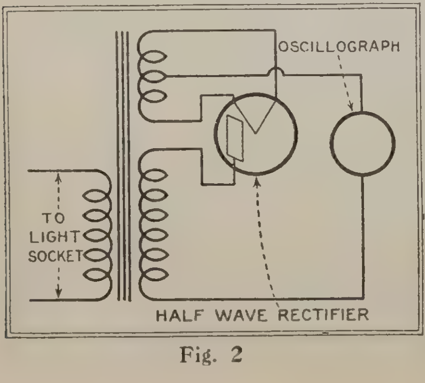


Fig. 2

Seeing Is Believing

Before getting down to brass tacks and determining just how a "B" supply device changes a.c. to d.c. (abbreviations for alternating current and direct current), we ought to get clearly in mind the exact difference between them. For this purpose we can best make use of an instrument called the oscillograph, a word derived from the Latin "oscillare," to swing, and "graph," to draw. The oscillograph is an instrument which will make visible to our eyes the manner in which any electric current is varying—in other words, the movement in the oscillograph will "swing" to and fro in accordance with the variations in the current flowing through the device and by means of a pencil of light will trace on a screen the exact form of this current. Now let us suppose that we take an oscillograph and connect it first to the light socket and then to the output of a "B" power unit and then compare the forms of the two currents. We will then be able to go back to the "B" power unit, study its various parts, and determine how the different sections of the unit gradually change the form of the current from a.c. to d.c.

If we connect an oscillograph to a light socket supplying a.c. current we would find that the picture on the screen of the device had a shape very similar to that shown in A of Fig. 1. If we shut off the current we would find the tracing to be simply a straight line, as indicated by the dotted line in Fig. 1-A. We call this dotted line the "zero line," for it is the tracing obtained with zero current flowing through the oscillograph. Whenever the tracing passes through or touches this line it indicates that at that moment the current through the oscillograph is zero. Now, keeping these facts in mind, let us examine the a.c. curve of Fig. 1-A. We note that the current starts from zero, indicated by the 1, gradually increases until it reaches a maximum at point 2, then it gradually decreases until it reaches zero at point 3, and then it starts to increase but in the opposite direction. It finally reaches a maximum in the opposite direction at point 4, when it begins to decrease and again reaches zero at point 5. At this point it starts to repeat this act, going again to a value corresponding to point 1, then 2 and so on. The changes between point 1 and point 5 represent a complete cycle, and if the house supply is 110 volts 60 cycles, we would find that the oscillograph indicated that the current went through 60 of these complete cycles every second.

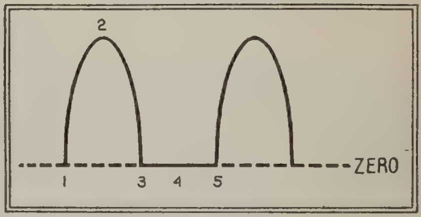


Fig. 3

In Fig. 1-B we illustrate the tracing the oscillograph would give if it was connected to the output of a "B" power unit. We again indicate the zero line as a horizontal dotted line and above it is the direct-current tracing. We note that it is simply a straight line, representing an absolutely constant current. There are certainly quite obvious differences between

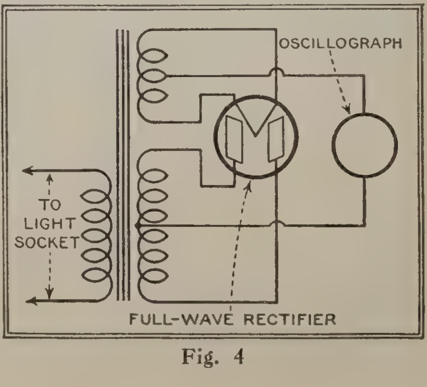


Fig. 4

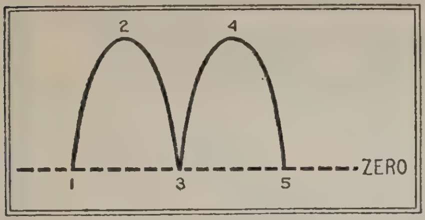


Fig. 5

A and B of Fig. 1. One is absolutely constant in magnitude and direction and the other is constantly varying and changing its direction.

Changing A.C. to D.C.

Now by gradual stages we have got to change this a.c. to d.c. One of the most important differences between the two forms of current is that the a.c. changes its direction whereas the d.c. always flows in the same direction. The first job, therefore, is to in some way change the a.c. current so that it always flows in the same direction.

This is accomplished by means of a rectifier, of which there are two types, half-wave rectifiers and full-wave rectifiers. If we connect the leads from the light socket to a transformer (the reason why a transformer is used will be explained later) and connect the secondary of the transformer to a half-wave rectifier and finally connect our oscillograph to the output of the rectifier as indicated in Fig. 2 we would get a tracing as indicated in Fig. 3. Here we note that the form of this curve over the section 1-2-3 is exactly the same as the similar section in Fig. 1-A, but that the section 3-4-5 lies right along the zero line, whereas previously the current had reversed as shown in Fig. 1-A. Therefore by means of the half-wave rectifier we have eliminated the lower half of the original a.c. current. As a result we have a current which, although it is not constant in value, does nevertheless always flow in the same direction—and this is a characteristic of a direct current. The current shown in Fig. 3 starts at zero, indicated by the 1, rises to a maximum at 2, decreases to zero at 3, and then remains at zero through 4 and 5, where it again begins to rise. The tube we used is called a half-wave rectifier because it permits only half of the a.c. current to pass through it, suppressing the other half.

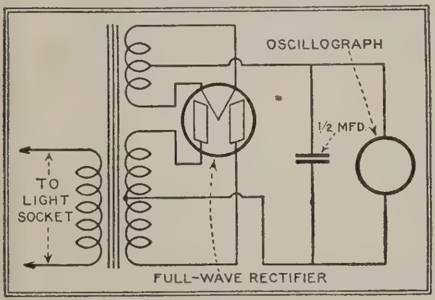


Fig. 6

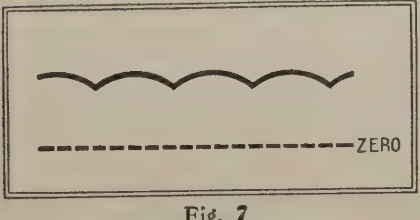


Fig. 7

If, instead of using a half-wave rectifier we had used a full-wave rectifier, as indicated in Fig. 4, we would find that our oscillograph traced the curve indicated in Fig. 5. Here we note that no part of the a.c. current has been suppressed but that the lower half has in effect been turned upside down so that now it appears in the upper half of the drawing. The output current from a full-wave rectifier therefore starts at zero indicated by the 1, rises to a maximum at 2, decreases to zero at 3, and then begins again to rise in the same direction, reaching a maximum at 4 and decreasing to zero at 5.

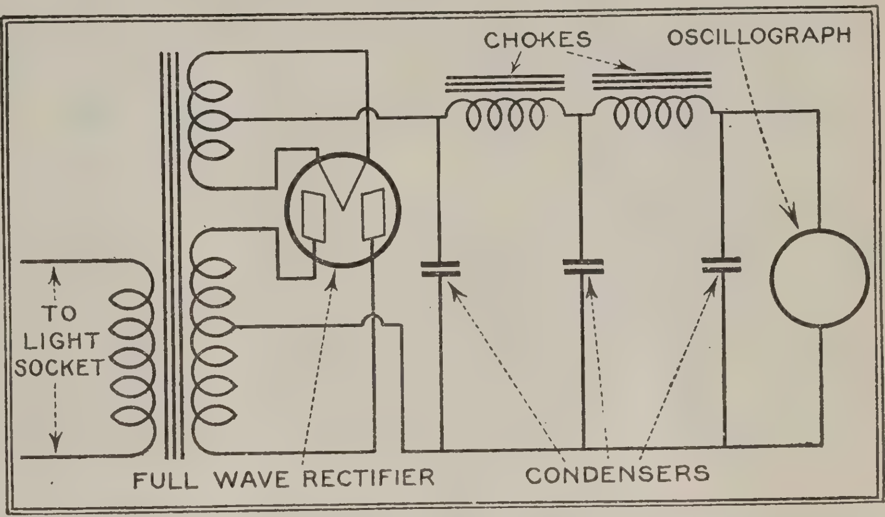


Fig. 8

Now we have analyzed the output of both full-wave and half-wave rectifiers. It should be noted that the forms of the currents, as indicated in Fig. 3 and in Fig. 5, are essentially the same, the full-wave rectifier simply giving an output current having twice as many peaks as that delivered by a full-wave rectifier. Since the action of the remainder of a "B" power unit is the same with either a full- or half-wave rectifier, we will assume from this point on that we are using a full-wave rectifier, giving a current of the form indicated in Fig. 5. It should be realized that the following description will apply equally well if we had used a half-wave rectifier.

Why Filter Condensers and Chokes Are Used

We now have to work with the output of a full-wave rectifier as indicated in Fig. 5 and we have to change it to a direct current of the form indicated by sketch B of Fig. 1. If we now connect a condenser of ½ to 2 mfd. capacity across the output of the rectifier and connect our oscillograph as indicated in Fig. 6, we would find that the current had undergone a considerable change, due to the presence of the condenser across the output of the rectifier. The tracing we now get on the oscillograph is that indicated in Fig. 7. Here we note that we still have a small peak corresponding to each peak in the original output of the rectifier (Fig. 5) but that the current no longer goes down to zero and instead just decreases a small amount.

This change in the form of the current is due to the fact that condensers have the ability to take a "charge" of current. We have all, at one time or another, probably placed a condenser across 90 volts of "B" battery and then touched the terminals together to see if the condenser had taken a charge as indicated by a spark as the terminals were brought close to each other. The condenser, in other words, can take in some current and store it up. In a "B" power unit the condenser takes a charge every time the current increases and then when the current decreases the condenser begins to discharge. So, during the time when the current would ordinarily tend to decrease and go to zero, the condenser discharges and helps to keep the current in the circuit more nearly constant. This is the effect that takes place in a circuit like that shown in Fig. 6.

We have approached quite close to our goal, which is a pure direct current. The current we have now is quite similar, except that it has some slight wiggles in it which are not present in a pure direct current. At this point we might look at the tracing of Fig. 7 in a somewhat different fashion. We can think of it as being a pure direct current with some little variations superimposed on it. The problem is therefore to utilize circuits which will pass direct current but which will not permit the passage of any variations in the current as represented by the wiggles. For this purpose we use more condensers and also choke coils which consist of a large number of turns of wire wound on an iron core. We arrange them in a circuit as indicated in Fig. 8,

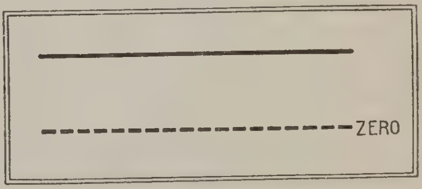


Fig. 9

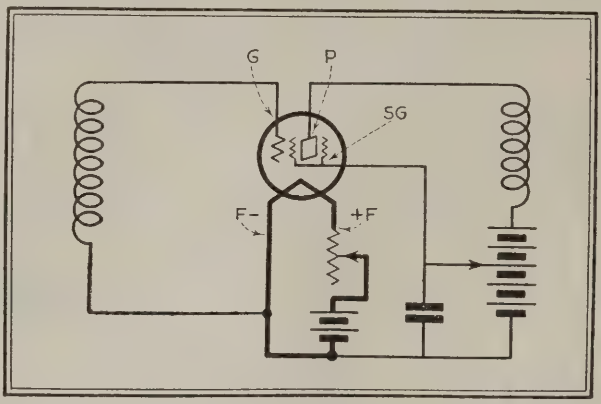
(*Continued on page* 1063)

RADIO NEWS INFORMATION SHEETS

By Elmore B. Lyford

Four-Element Tubes

Index No. R-334.1



THE four-element tubes of today have their origin in the work of Schottky, a German scientist, many years ago, and in the more recent work of Hull and Williams of the G. E. Research Laboratories. While the screen-for-the-grid tube is only one of the ways in which this fourth element may be used, it is the most important, and we shall confine this discussion to it alone.

The usual three-element tube has a rated amplification factor of around 8. Experimental tubes of this type have been built with an amplification factor of 300 or more, but they are practically useless at broadcast frequencies. The capacity between the plate and grid of the tube (which act as the two plates of a tiny condenser) is sufficient at these frequencies to allow an appreciable amount of energy to "leak back" from the plate to the grid. This causes reduced signal strength, distortion and howling, and presents a very practical limit to the "mu," or ability to amplify, which this type of tube may be built to have.

If another element is built around the plate, however, in such a manner as to screen it electro-statically from the control grid, and yet in the form of a mesh so that electrons from the filament can get through, this feedback effect within the tube may be greatly reduced. This has been done in our present screen-grid tubes, and the amplification factor has been increased to around 400. While this value cannot be fully attained in practice, the tube nevertheless can be made to give many times the amplification of the three-element tube, when used in circuits similar to the one illustrated.

As may be seen from this diagram, the screen-grid has a positive potential. The screen-grid is by-passed to the filament by the condenser shown, effectively "grounding" it for radio-frequency currents. There is now a capacity between the plate and screen-grid, which is harmless. Any effective capacity between the plate and control grid, which caused the "feed-back," has been practically eliminated; the feed-back also disappears.

RADIO NEWS INFORMATION SHEETS

By Elmore B. Lyford

Shielding

Index No. R-387.1

SHIELDING is used in practically every modern radio receiver, where it serves two distinct purposes. These are:

1. To reduce interstage reaction, or the effect of any stage upon the adjacent ones within the receiver itself.
2. To prevent direct pick-up, by the coils and wiring, of the signals of nearby transmitting stations.

The first of these two purposes is the more important, and for this reason each radio-frequency amplifying stage of the receiver is usually completely enclosed within a metal can, with small holes provided to allow the necessary wires and control shafts to enter and leave.

To accomplish the second of these purposes, the entire receiver is sometimes completely enclosed as a unit within a second metal box. This is necessary only in the case of proximity to powerful transmitting stations, and even there the interstage shielding is sometimes sufficient.

In either case, however, the shielding works in two ways—as an electrostatic shield and as an electromagnetic shield. As an electrostatic shield, to limit the extent of fields set up by the capacity of any one piece of apparatus to any other, each acting as one plate of a tiny condenser, its functions are simple. These capacities are small at best, and almost any thin sheet of metal is ample to nullify the effect. Even an open wire mesh is sufficient.

In the case of electromagnetic fields, however, the job of the shield is more difficult. These are the fields which exist around coils and wires through which currents are flowing, and they may be relatively quite strong. Shields to limit the effect of these electromagnetic fields should be almost air-tight to be entirely effective, and whatever holes are necessary in them must be as small and as nearly metal-filled as possible.

These electromagnetic fields possess the power of generating electric currents, termed "eddy currents," in any metal within their field, including the shielding. Because of this, the shielding must be of low-resistance metal—a good electrical conductor—and it must be of sufficient thickness so that its resistance is negligible. Even a good conductor such as copper will have considerable resistance if it is very thin.

For this reason, the shields in our radio receivers are generally made of copper, aluminum or brass, copper being the best conductor of the three. For mechanical strength, however, sheets of No. 20 B. and S. gauge or heavier are used, and with these thicknesses any one of these metals may be used.

There is one other effect of shielding which has not yet been mentioned, though it is important. This is the increase in the r.f. resistance of a coil due to adjacent shielding. This is a detrimental effect, but with proper design it may be made small enough to do no harm.

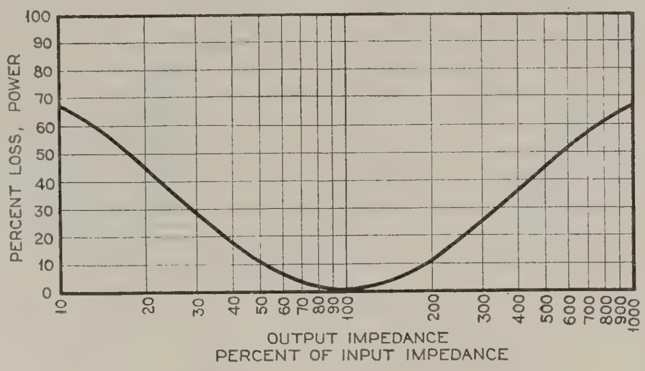
This increase in coil resistance depends upon frequency and upon the nearness of the shield to the coil. It will be negligible in most cases, however, if the shield is at least an inch from the sides of the coil, and not within two inches of either end. The reason for the larger distances at the ends of the coil is that the electromagnetic field of the coil is stronger there than at the sides and must therefore be given more room.

RADIO NEWS INFORMATION SHEETS

By Elmore B. Lyford

The Importance of Matching Impedances

Index No. R-145.1



IN electrical circuits of every description it is of primary importance that the output impedance of each device should be as nearly as possible equal to the input impedance of the device into which it feeds or works. This rule applies just as strongly to all radio circuits and devices—to tubes working into transformers or resistances, to transformers which work into tubes, or into loud speakers, or into other transformers.

The importance of matching impedances lies in the fact that it is by this means that we can transfer power (watts) from one circuit to another with the least possible loss. The accompanying chart shows the percentage loss of power which occurs when two adjoining impedances do not match. From it may be computed the percentage loss of power when the output impedance is anything from one-tenth to ten times the impedance into which it feeds.

For example, if the output impedance of a transformer is just twice the value of the impedance of a loud speaker into which it is working, the power loss will be ten per cent.—the loud speaker will receive only nine-tenths as much power as it would if the impedances were equal.

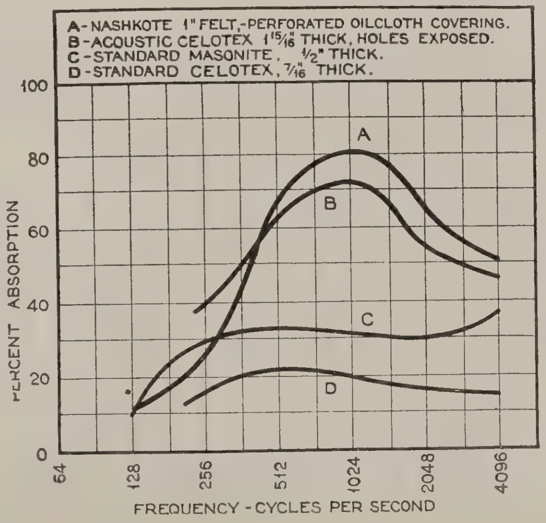
There is one notable exception to this rule as applied to radio circuits, and this is in the case of a vacuum tube working into some following device. Due to the fact that the "characteristic curve" of a vacuum tube is not a straight line, the condition for maximum *undistorted* power transfer from the tube is when the following device has an impedance *twice* the plate impedance of the tube itself. Since in radio work distortion is to be avoided whenever possible, circuit constants are always arranged wherever possible so that each vacuum tube works into an impedance double its own plate impedance, or more. This is one of the very few electrical cases where we do not try for maximum power transfer, for here fidelity is more important, and efficiency must take the second place. This is not a violation of the rule of equal impedances, however. Equal impedances here would also give a greater output, but it would not be entirely distortionless.

RADIO NEWS INFORMATION SHEETS

By Elmore B. Lyford

Sound Absorption—Prepared Materials

Index No. R-534.12



THE ability of any material to absorb sound depends to a large extent upon the porosity of the surface of that material. The sound waves penetrate the pores of the material, are broken up and finally are dissipated as heat.

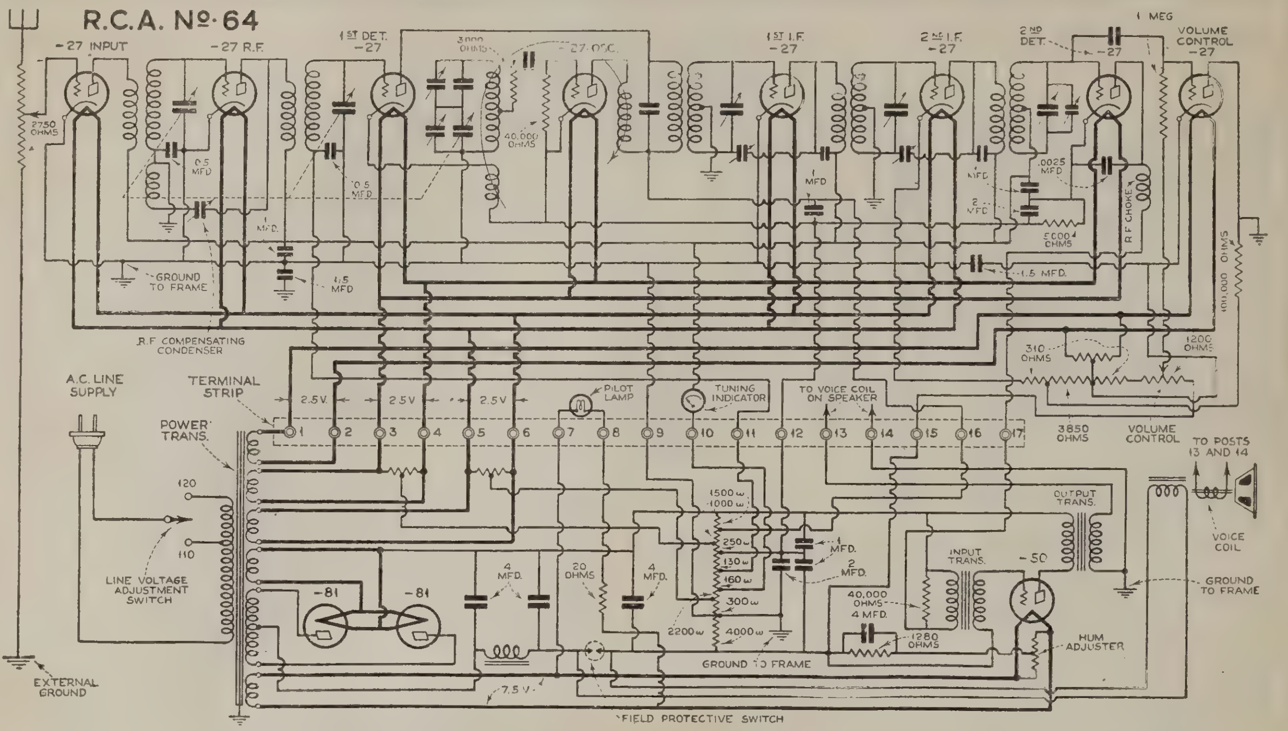
Many ordinary materials, such as felt and heavy cloths like velvet, are quite good sound absorbers, and are much used for this purpose wherever it is desirable to prevent reverberation and echo, as in churches, theatres, auditoriums, etc. The advent of broadcasting and the talking movies, however, has created a demand for very effective, concentrated sound-absorbing materials for use in the various studios, and many materials are now being manufactured almost entirely for this use.

The accompanying graph illustrates the sound-absorbing qualities of four of these prepared sound-absorbing materials. These are not the only ones available, but they are a representative selection.

It may be seen that none of these materials absorbs all frequencies equally well and that the greatest variation comes with those whose peak absorbing power is the largest. Any one of them, however, is a much better absorber than the brick or plaster or wooden walls which they are designed to cover, for such surfaces in general absorb only from two to ten per cent. of the sound which strikes them.

Nashkote is the trade name for a prepared hair-felt about one inch in thickness, made with an oilcloth covering which is perforated with many small, close-set holes. Celotex and Masonite are both wall-boards made from compressed fibres, while Acousti-Celotex is a thicker variety of the same material, studded with many small holes set close together and extending through almost the entire thickness of the material. The very high sound-absorbing power of this last-named material is due in large part to these holes. They give a much larger effective "surface" for the material to present to the incident sound wave, and increase the absorption accordingly.

Radio News Manufactured Receiver Circuits


R.C.A. Nº·64
-27 INPUT
2750 OHMS
-27 R.F.
0.5 MFD
1 MFD.
1ST DET. -27
0.5 MFD
3000 OHMS
-27 OSC.
40,000 OHMS
1ST I.F. -27
1 MFD
2ND I.F. -27
1 MFD
2 MFD
2ND DET. -27
.0025 MFD
5000 OHMS
R.F. CHOKE
1 MEG
VOLUME CONTROL -27
100,000 OHMS
1.5 MFD.
GROUND TO FRAME
1.5 MFD
R.F. COMPENSATING CONDENSER
310 OHMS
1200 OHMS
A.C. LINE SUPPLY
TERMINAL STRIP
2.5V.
2.5V
2.5V
PILOT LAMP
TUNING INDICATOR
TO VOICE COIL ON SPEAKER
3850 OHMS
VOLUME CONTROL
TO POSTS 13 AND 14
POWER TRANS.
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
120
110
LINE VOLTAGE ADJUSTMENT SWITCH
-81
-81
4 MFD.
20 OHMS
4 MFD.
1500 ω
1000 ω
250 ω
130 ω
160 ω
300 ω
2200 ω
4000 ω
1 MFD.
2 MFD.
OUTPUT TRANS.
VOICE COIL
INPUT TRANS.
-50
GROUND TO FRAME
40,000 OHMS
4 MFD.
1280 OHMS
HUM ADJUSTER
GROUND TO FRAME
EXTERNAL GROUND
7.5 V.
FIELD PROTECTIVE SWITCH

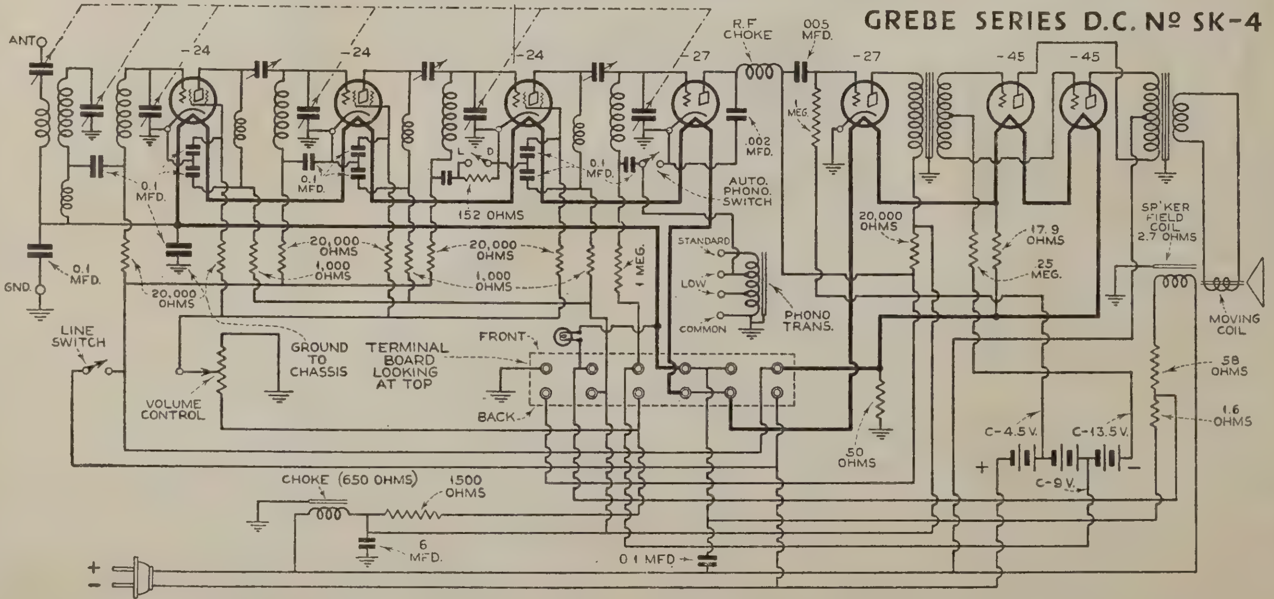
AMONG the commercial superheterodynes perhaps none enjoys so great a popularity as the R. C. A. Superheterodyne, Model 64. Many of these receivers are still in use and the serviceman will find it to his benefit to know as much as possible about the circuit details of this receiver.

Eight -27 tubes, a pair of -81's and a single -50 tube are employed. The -81's comprise the rectifier, the -50 is used in the power output circuit and the -27's are used as follows: one in the antenna-coupling circuit, one in a tuned r.f. stage, one as a first detector, one as an oscillator, two in the i.f. stages, one as a second detector and one as an automatic volume control.

Values of resistors, which may require replacement in servicing, are indicated on the circuit, shown above.

This receiver is one of the few which contain a meter or indicating device for visual tuning.

Radio News Manufactured Receiver Circuits


GREBE SERIES D.C. Nº SK-4
ANT.
-24
-24
-24
-27
R.F. CHOKE
.005 MFD.
-27
-45
-45
1 MEG.
.002 MFD.
0.1 MFD.
0.1 MFD.
0.1 MFD.
L
D
AUTO. PHONO. SWITCH
152 OHMS
GND.
0.1 MFD.
20,000 OHMS
1,000 OHMS
20,000 OHMS
1,000 OHMS
20,000 OHMS
1 MEG.
STANDARD
LOW
COMMON
PHONO TRANS.
20,000 OHMS
17.9 OHMS
.25 MEG.
SP'KER FIELD COIL 2.7 OHMS
MOVING COIL
LINE SWITCH
GROUND TO CHASSIS
TERMINAL BOARD LOOKING AT TOP
FRONT
BACK
VOLUME CONTROL
.50 OHMS
58 OHMS
1.6 OHMS
C-4.5 V.
C-13.5 V.
C-9 V.
+
-
CHOKE (650 OHMS)
1500 OHMS
6 MFD.
0.1 MFD.
+
-

CATERING to the needs of those radio folk residing in districts supplied with d.c., the Grebe d.c. receiver type SK-4 is one widely used.

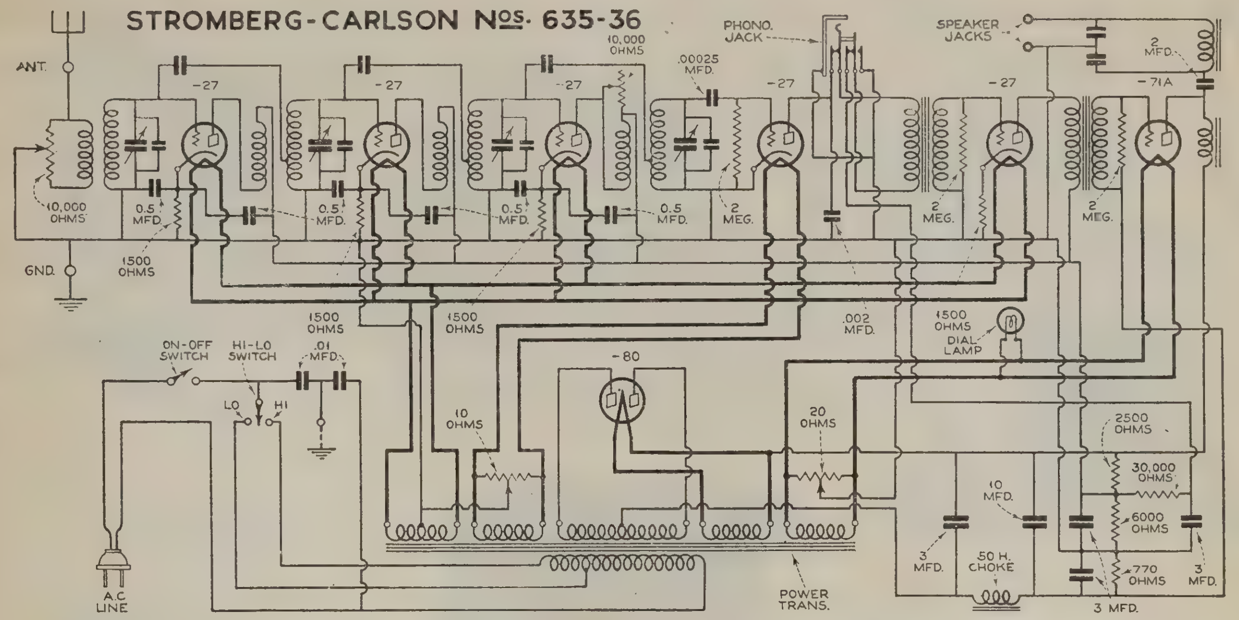
Servicing of such a receiver, because of its peculiar series-filament circuit connection, requires an alertness on the part of the serviceman which is not so often the case in the testing and servicing of the more common a.c. receivers. Should one tube burn out, then whole groups of tubes will not receive filament current.

As in many receivers now being offered for use in automobiles, use is made of the a.c. type tubes in a d.c. circuit.

In the r.f. end, of which there are three tuned stages, three -24 type tubes are employed while the detector and first audio stages use type -27 tubes. The power output stage employs a pair of -45's in push-pull.

The receiver is furnished with a dynamic loud speaker, insuring fine tone quality.

Radio News Manufactured Receiver Circuits

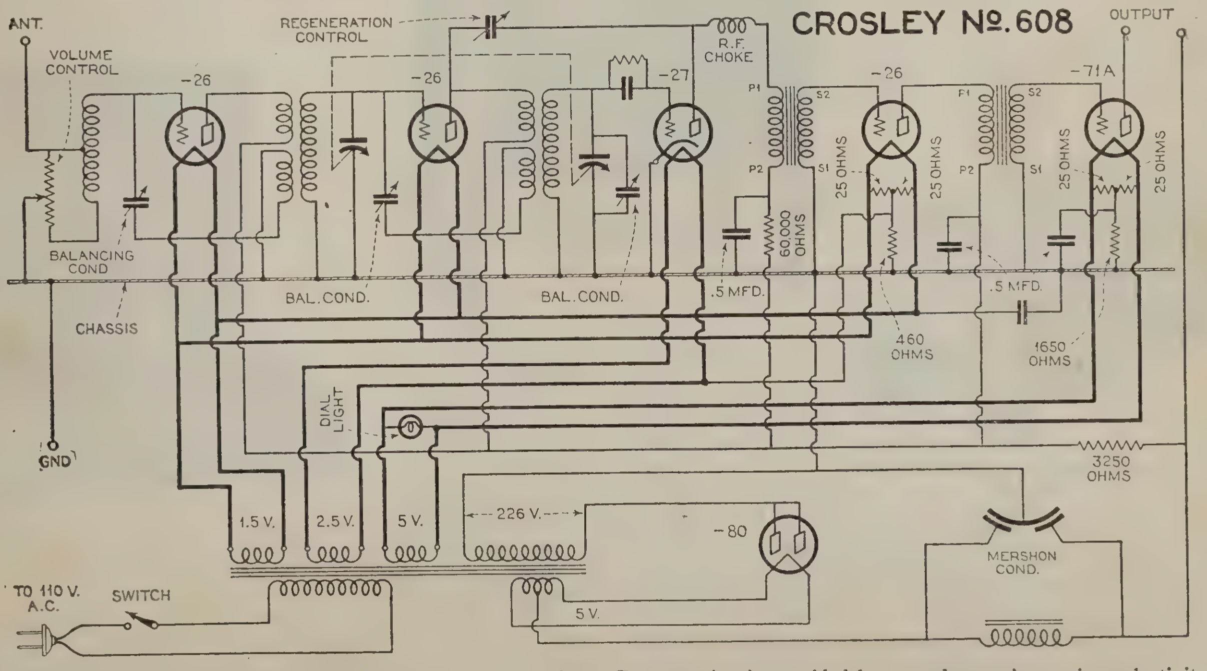

STROMBERG-CARLSON Nos. 635-36
ANT.
GND.
10,000 OHMS
0.5 MFD.
1500 OHMS
-27
-27
-27
10,000 OHMS
.00025 MFD.
-27
PHONO. JACK
SPEAKER JACKS
-27
2 MFD.
-71A
0.5 MFD.
0.5 MFD.
0.5 MFD.
2 MEG.
2 MEG.
2 MEG.
1500 OHMS
1500 OHMS
.002 MFD.
1500 OHMS
DIAL LAMP
ON-OFF SWITCH
HI-LO SWITCH
.01 MFD.
LO
HI
-80
10 OHMS
20 OHMS
2500 OHMS
30,000 OHMS
10 MFD.
6000 OHMS
3 MFD.
50 H. CHOKE
770 OHMS
3 MFD.
3 MFD.
A.C. LINE
POWER TRANS.

In this seven-tube Stromberg-Carlson broadcast receiver three –27 tubes are used in the radio-frequency amplifying circuit, a –27 tube is employed in a grid leak and condenser detector circuit and another –27 tube in the first audio stage, while a –71A completes the audio channel.

A –80 full-wave rectifier supplies plate potential to the tubes in the radio receiver.

Provision is made for a phonograph pickup connection to a jack, using the audio amplifier of the receiver to amplify the recording. A modified form of neutralization is employed in this circuit to stabilize the radio-frequency amplifier, while resistors shunted across the audio transformer secondaries are used in the audio amplifier for producing an output of satisfactory tone quality.

Radio News Manufactured Receiver Circuits


CROSLEY No. 608
ANT.
VOLUME CONTROL
-26
REGENERATION CONTROL
-26
-27
R.F. CHOKE
OUTPUT
-26
-71A
P1
S2
P2
S1
P1
S2
P2
S1
25 OHMS
25 OHMS
25 OHMS
25 OHMS
60,000 OHMS
BALANCING COND
BAL. COND.
BAL. COND.
.5 MFD.
.5 MFD.
CHASSIS
460 OHMS
1650 OHMS
DIAL LIGHT
GND
3250 OHMS
1.5 V.
2.5 V.
5 V.
226 V.
-80
MERSHON COND.
TO 110 V. A.C.
SWITCH
5 V.

The Crosley No. 608 receiver employs six tubes in its circuit as follows: three –26 tubes are required, two for the radio-frequency amplifier, the other in the first stage of audio amplification; a –27 indirect heater type tube as the detector; a –71A in the second or output audio stage and a –80 rectifier in the power supply.

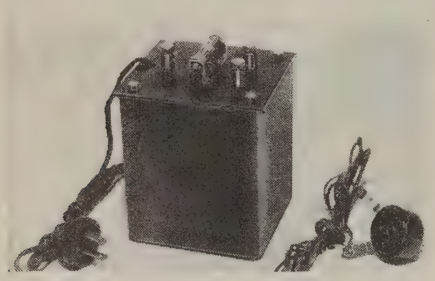
The volume control in this circuit is shunted directly across the antenna coil, the rotating member being grounded. Regeneration is provided by a condenser, increasing selectivity and sensitivity.

By means of a balancing condenser and bucking coil a high degree of stability is obtained, increasing the performance factor of the receiver as a whole. A high capacity, double element Mershon condenser is employed in the "B" filter circuit.

NEWS *from the* MANUFACTURERS

A New –45 Adapter

So that sets now equipped with the –71 power tube may be brought up to date the Brooklyn Radio Service Corporation announce a new adapter for the –45 super-power tube. This unit is supplied completely wired and provides the correct A voltage for the filament of either a single or push-pull –45 output stage. Adapter sockets are employed to plug into the present sockets of the radio receiver, eliminating the likelihood of tube breakage which would likely occur if the power tubes were used in an external unit. An automatic C bias is arranged for in the unit, eliminating entirely the necessity of external dry C batteries or fussing with connections in the interior of the radio receiver. The adapter is for use on 110 volts 60 cycle a.c. lighting lines. The unit is encased in a metal container having a bakelite panel suitably engraved.

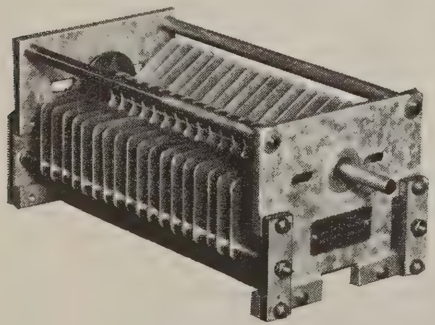


The Brooklyn Radio power stage adapter

National Transmitting Condenser

Designed especially to meet the demand for moderate price stock transmitting condensers for a higher power work than covered by former models, the National Company, Inc., announce the new National series TMU 5,000-volt and 7,500-volt transmitting condenser.

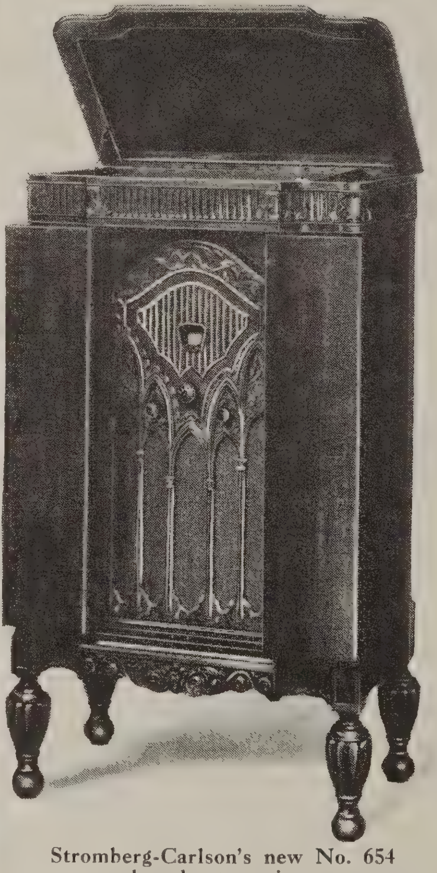
These condensers employ all the very latest features for efficiency, steadiness of signal and rigidity of construction. The end plates are rugged cast aluminum. All rotor and stator plates have rounded and polished edges. The shaft is ⅜ of an inch in diameter and operates in a special accurately machined conical and ball bearings. A special high current low impedance rotary brush type rotor contactor is also incorporated in the design. The new type TMU condensers are obtainable in a range of capacity from .0005 mfd. to .00005 mfd.



A new short-wave transmitting condenser, by National

A Radio-Phonograph Combination

The leading developments of screen-grid radio receiver circuits are combined with the outstanding advantages in electrical phonograph design in the new No. 654 combination recently announced by the Stromberg-Carlson Telephone Manufacturing Company.



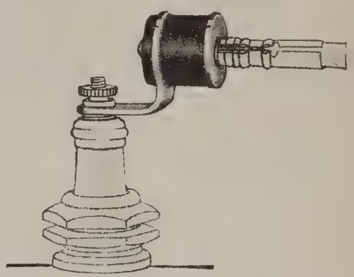
Stromberg-Carlson's new No. 654 broadcast receiver

Triple screen-grid radio amplification makes possible linear power detection and single-stage audio output in the radio part of the combination. A non-rattling moisture-proof cone is used in the scientifically baffled electro-dynamic speaker. The speaker is of such sensitivity that the output of the single –45 tube in this particular instrument will give pure and natural tone of room-filling volume. The No. 654 is operated by three control knobs, a single station selector, a volume control and an off-and-on switch.

For playing phonograph records with this instrument a turntable is provided, rotated by a silent electric motor. A magnetic pick-up passes the record output through the audio system of the radio receiver and the extra-sized electro-dynamic speaker.

Automobile Resistors for Radio-Equipped Cars

The Allen-Bradley Co. announce a complete line of automobile resistors for the suppression of interference from ignition systems in radio-equipped cars. These resistors are furnished to provide individual units for each spark plug and for the common cable to the distributor. The resistors increase the resistance of the high-tension ignition system and minimize the disturbing oscillations in the ignition circuit which interfere with the operation of a radio receiver in the motor-car. When used with suitable by-pass condensers in other parts of the ignition circuit, the use of shielded ignition cables is avoided.



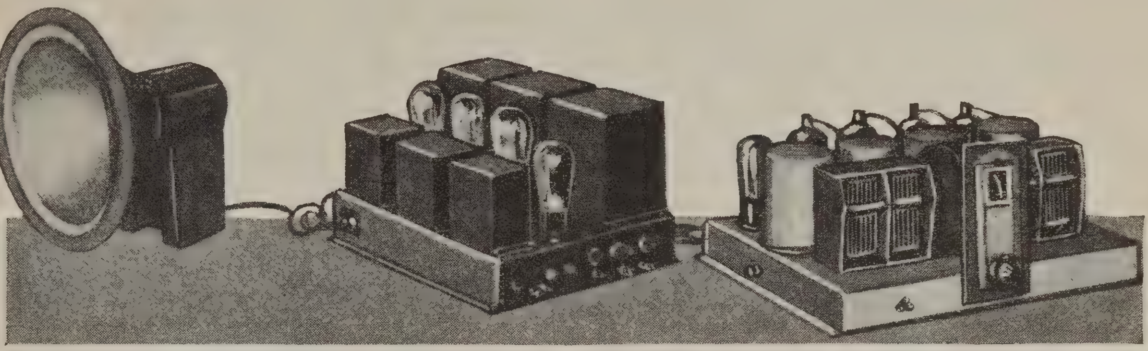
The Allen-Bradley resistor for motor ignition suppression

The Stevens a.c.-operated portable phonograph

Dynamometer tests indicate that the power output of engines is unaffected by the use of resistors and cold tests also reveal that they introduce no difficulty in starting up motors in cold weather. Their resistance values are approximately 25,000 ohms, being so constructed that they suffer no appreciable deterioration or change of resistance even after long use.

(*Continued on page* 1052)

~RADIO NEWS HOME LABORATORY EXPERIMENTS~



The units comprising an a.c. radio receiver. Whether it be battery operated or a.c. operated, the essentials comprise: A tuner, a sensitive detector, an efficient audio channel and a loud speaker capable of faithful tone reproduction

Analyze Your Radio Receiver!

An explanation of the fundamental principles underlying the operation of modern broadcast receiving equipment

EVERY radio receiver may be divided into six fundamental sections—the antenna, the radio-frequency amplifier, the detector, the audio-frequency amplifier, the loud speaker and the power unit. Each of these sections has a definite and distinctly separate function. Let us, in this sheet, study in its broad outlines the operation of these various units in a modern radio receiver, leaving a detailed discussion for future sheets. Here we can get down in black and white the important facts—and while a group of facts does not represent knowledge they are at least the foundation upon which knowledge can be built.

Briefly the task of a receiver is to take the conglomeration of signals picked up by the antenna, select it by means of tuned circuits (see April Study Sheet), amplify it, change its form, amplify it again, change it from electrical to mechanical energy and then to acoustical energy in the form of sound waves. The process is complicated, and a fundamental understanding of it not altogether a simple matter.

The Antenna

The antenna that we place around the moulding of a room or put up on the roof has induced in it feeble currents from all the radio broadcasting stations whose signals reach it. These currents may be comparatively large, for example, a tenth of a volt or more, but more frequently they are very small—sometimes but a few millionths of a volt. Some modern sensitive receivers will give medium volume from the loud speaker when the total voltage induced in the antenna is in the order of 15 or 20 microvolts (millionths of a volt). Such sensitivity has been made possible by the use of several stages of screen-grid radio-frequency amplification.

The voltages induced in the antenna cause currents to flow in the circuit and these currents flowing through the antenna-ground system of the receiver produce a voltage across the primary or antenna circuit which finally results in a voltage being produced across the grid circuits of the first r.f. amplifier tube.

The antenna at the receiver therefore is used as a collector of energy, while at the broadcast transmitter station it is used as a radiator of energy. Generally the higher and longer the receiving antenna, the greater the energy it collects, and the louder the program. But modern receivers, because of their sensitivity and great amplification power, give excellent results with small indoor or outdoor antennæ—and if only local reception is desired a few feet of wire attached to the antenna post is sufficient.

The Radio-Frequency Amplifier

The voltages developed across the antenna circuit of a receiver are too small to use directly and they must therefore be amplified. The radio-frequency amplifier circuits, consisting of tubes and radio-frequency transformer, are used for this purpose. An ordinary type –01A tube with a properly designed transformer amplifies the signal about ten times—two –01A's therefore give an amplification of about 100. The gain obtained from the screen-grid tubes is much higher—some modern receivers work with a gain per tube of about 40 and others with a gain of perhaps 60. Two screen-grid tubes, each with a gain of 40, give a total amplification of 1,600.

Some increase also is obtained from the radio-frequency transformer connecting the antenna to the grid of the first tube. A gain of ten may be obtained here. Therefore a receiver with two –01A tubes has a total radio frequency gain of about 1,000. A set with two screen-grid tubes each with a gain of 40 has a total overall amplification of about 16,000. If each tube gave a gain of 60 the overall would be $60 \times 60 \times 10 = 36{,}000$. With such an amplifier, if the total induced antenna voltage was 10 millionths of a volt (ten microvolts), then the voltage output from the amplifier would be 360,000 microvolts or 0.36 volts.

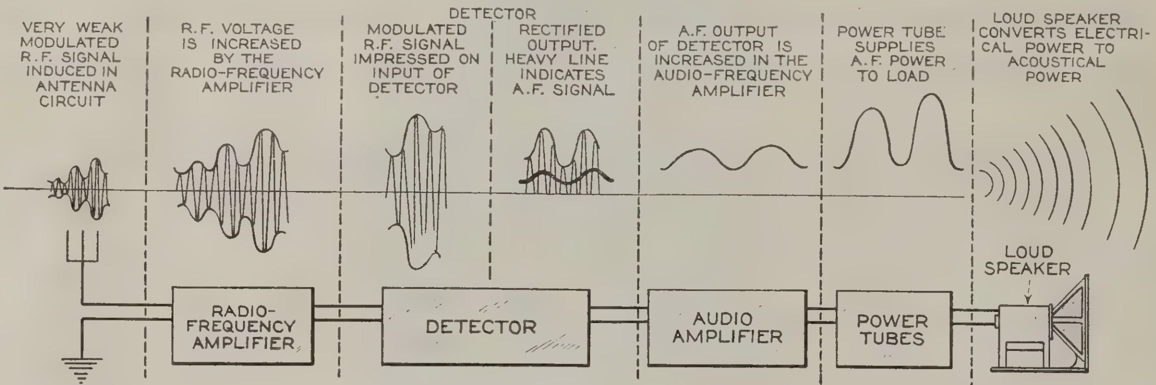
Increasing the voltage of the signal is really the major function of the radio-frequency amplifier, but in modern tuned radio-frequency amplifiers the tuned transformers connected between the tubes serve also to select the desired signal and weed out the undesired signal. There are many signals, some weak, some strong, impressed on the antenna circuit and the radio-frequency amplifier in the usual receiver amplifies the desired signal and also eliminates the undesired signal.

The modern r.f. amplifier therefore does two things—it increases the voltage of the desired signal and at the same time eliminates all the undesired signals.

The Detector

The voltage output from the radio-frequency amplifier varies in amplitude in accordance with the speech or music impressed on the carrier at the transmitting station. This signal is inaudible when received and it first becomes necessary to detect or rectify it so as to get a current that will slowly vary in accordance with the changes in amplitude of the carrier. Such a current is obtained by the process of detection and is indicated in the diagram as A. An explanation of exactly how the detection takes place must be left to a future study sheet—we are concerned here only with the fundamental functions of the various sections of receivers. The important point now is that at the input to the detector is a varying radio-frequency voltage (engineers call it a "modulated" r.f. voltage) and at the output is a current that slowly varies in accordance with the changes in amplitude of the detector input voltage. And since the changes in amplitude of the carrier were produced originally by impressing audio-frequency voltages on it, the detector output, varying in accordance with the changes in carrier amplitude, will contain the same audio-frequency components that were picked up by the microphone at the broadcasting station. Present-day receivers using "power detectors" frequently operate with r.f. inputs of several volts.

The detector output current is therefore an audio-frequency current—that is, it is varying at a rate that would be audible to the ear—if the ear could hear electric currents. But the ear depends upon sound waves and we must therefore convert these audio-frequency currents into sound waves.


DETECTOR
VERY WEAK MODULATED R.F. SIGNAL INDUCED IN ANTENNA CIRCUIT
R.F. VOLTAGE IS INCREASED BY THE RADIO-FREQUENCY AMPLIFIER
MODULATED R.F. SIGNAL IMPRESSED ON INPUT OF DETECTOR
RECTIFIED OUTPUT. HEAVY LINE INDICATES A.F. SIGNAL
A.F. OUTPUT OF DETECTOR IS INCREASED IN THE AUDIO-FREQUENCY AMPLIFIER
POWER TUBE SUPPLIES A.F. POWER TO LOAD
LOUD SPEAKER CONVERTS ELECTRICAL POWER TO ACOUSTICAL POWER
LOUD SPEAKER
RADIO-FREQUENCY AMPLIFIER
DETECTOR
AUDIO AMPLIFIER
POWER TUBES

Each portion of a radio receiver performs a definite function. The above drawing shows how the inaudible waves, first picked up by the antenna, undergo succeeding changes until the sound comes out of the loud speaker. Your dictionary will give you the meaning of such words as "modulated," "impressed," "rectified" and "acoustical"

The Audio-Frequency Amplifiers

We recall that in discussing the r.f. amplifier we said that it was necessary to increase the voltage of the r.f. signal before it could be utilized to operate modern detector circuits. Now again we have the same problem in connection with the audio-frequency voltage output of the detector. This voltage must be increased before it can be effectively utilized. This is the task of the audio-frequency amplifier.

The audio-frequency amplifier—like the r.f. amplifier—consists of tubes and transformers, the only difference being that the transformers in this case amplify audio-frequency rather than radio-frequency currents. There is a tendency in modern receivers to use but little audio-frequency amplification. The audio-frequency gain in some receivers may be about 25 in comparison with gains of 75 to 100 a year ago. It is possible to use lower audio-frequency gain because of the very high r.f. amplification obtained with screen-grid tubes and at the same time the use of but little a.f. gain means that the a.c. hum will be negligibly small.

The audio-frequency amplifier connects between the output of the detector and the input circuit of the power tubes and its only purpose in life is to increase the a.f. output of the detector to a point where the voltage will be sufficient to operate the power tube.

In the a.f. circuits between the detector and the input to the power tube we have been trying to increase the voltage of the signal. Having reached the grid or input to the power tube, we are no longer especially interested in voltage but instead desire to obtain as much audio-frequency power as possible. We therefore use tubes which are designed to supply power. The –71A, for example, will supply about 0.7 watts, the –45 about 1.6 watts, and so on. In most of today's receivers two type –45 tubes are used in push-pull, giving an output of 3 or 4 watts; this is about equal to the power required to heat the filaments of three type –01A tubes.

The power tubes are operated by the a.f. voltage built up by the audio-frequency amplifier and the circuits of the power tube are arranged so that the greatest possible power is obtained from the tube. We do this because we want to use the output of the power tube to operate a loud speaker and this requires power.

We will recall that, in discussing the detector, we found that it produced a very important change in the signal—at the input the signal was an r.f. voltage and at the output of the detector it was an a.f. voltage. In the loud speaker the signal undergoes another change, even more drastic. In the loud speaker its very nature is changed. We put electrical energy into the loud speaker. This causes the diaphragm to move and the movements of the diaphragm set up sound waves in the air. The sound waves in the air represent acoustical power which has been obtained from the electrical power fed into the loud speaker. The modern loud speaker is a very inefficient device delivering as acoustical power but 2 or 3 per cent. of the electrical power fed into it. The sound waves produced by the loud speaker enter our ears and we hear the result as music—or as static if there is a thunderstorm at the time.

We have, in the preceding discussion, taken a general survey of an entire radio receiver, beginning with the antenna and ending with the music that we hear. It has been pointed out how the antenna picks up the energy, the r.f. circuits amplify it and eliminate all but the desired signal, how the detector changes the signal from r.f. to a.f., the function of the audio amplifier is boosting the a.f. detector output, the power tube which supplies power to the loud speaker where the electrical energy is converted into acoustical energy.

Our discussion has been brief and to the point, stating what happens rather than how. In future lessons we will consider in more detail just how these various things are accomplished, so that, if you desire, you can investigate and experiment with receiver designs to greater advantage.

The Radio Forum

A Meeting-Place for Experimenter, Serviceman and Short-Wave Enthusiast

The Experimenter

Semi-Remote Control

NO matter where a radio receiver is located, one may now have the speaker in any room in the home and hear a favorite station. The set may be turned on or off automatically by plugging the speaker in a floor or base plug. This plug is a standard radio convenience outlet attached to the radio circuit and wired throughout the home for radio reception.

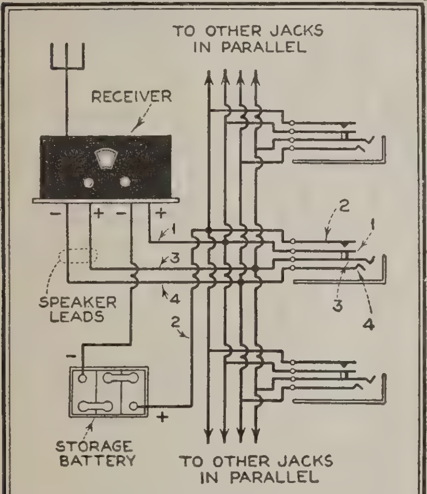


FIG. 1

The circuit for three paralleled jacks remotely located

One who wishes to be modern in every respect will easily realize the advantages of the following method. It should not, however, be confused with the remote-control tuning of stations, as it is only remote control operation of power.

This system may be used with any type of radio receiver, battery or electrically operated.

The wiring system to be operated by remote control of the filament is shown in Fig. 1. The antenna and ground connections are to the conventional antenna and ground. The speaker binding posts are connected to the cable leads 3 and 4.

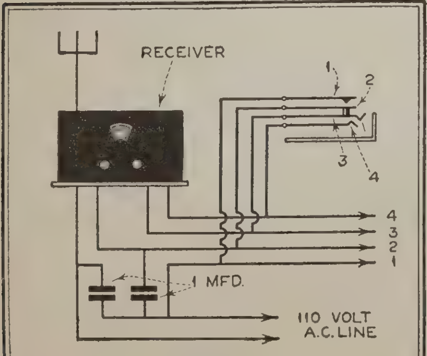


FIG. 3

The circuit for a paralleled jack when employed on an a.c. receiver

The terminals 1 and 2 on the jacks are the filament lugs, or, in the case of an electric set, the a.c. transformer connection. On tracing the wiring from these terminals 1 and 2 on the jacks, it will be found that when the loud speaker plug is disconnected the circuit will be broken and the set, which is located in a distant spot, is automatically turned off. Referring to Fig. 2, one will easily realize just what takes place when the loud speaker plug is inserted, and from a study of this jack with the end lug numbers, will be able to complete the wiring for this jack and the others which are in parallel with it.

In Fig. 3 the radio receiver is operated from the 110-volt lighting circuit. The connections in this type of control are very similar to the battery operated. The 110-volt a.c. line is here shunted with a 1 mfd. condenser to prevent arcing on the jack contact points when the plug is disconnected. For the speaker leads from the set to the various parallel jacks, number 16 wire should be used, while in the filament or power circuit number 14 will be required.

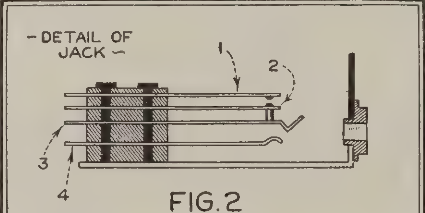


FIG. 2

Details of one of the paralleled jacks

Another feature worthy of notice is the simple relay construction by means of which a telegraph sounder may easily be converted into a simple relay which makes and breaks the supply current to the receiver at will. Such a type of simple structure is shown in Fig. 4, in which the two electromagnets are connected in series. In using a relay the length of wire is shortened, thus preventing any resistance entering in the filament circuit, due to long leads between the receiver itself and the parallel jacks. The operation of this relay is extremely simple. The two outside pillars, connected to either one leg of the 110-volt a.c. lighting line or to one side of the storage battery, make contact with the silver contact points on the armature, when the armature is pulled down against the magnets, thus completing the circuit and making the receiver ready to operate.

Fig. 5 is a schematic diagram of how this relay is connected in the circuit. The 2 mfd. condensers shunted across the a.c. supply prevents arcing on the silver contact points on the make-and-break of the relay. It should be remembered that these condensers should be of a sufficiently high voltage test to prevent breakdown at the voltage applied.

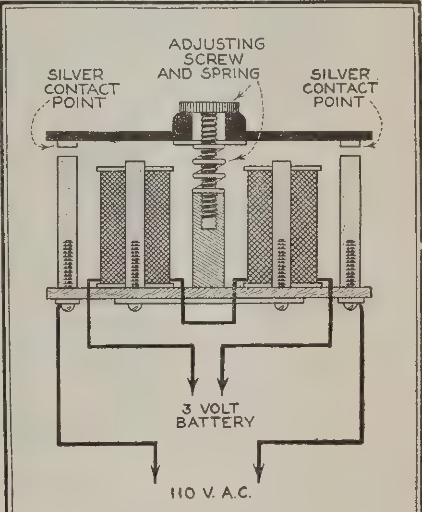


FIG. 4

Details of an auxiliary relay for "breaking" the a.c line, instead of at the jack

The local battery supply to be employed for attracting the relay magnet depends purely upon the resistance of the relay. Three volts may be used to good advantage, in which case the circuit should not exceed 25 to 30 ohms.

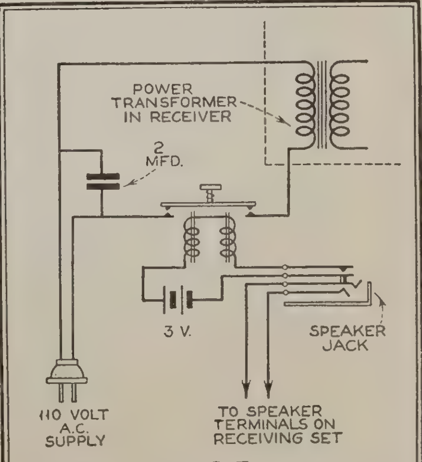

POWER TRANSFORMER IN RECEIVER
2 MFD.
3 V.
SPEAKER JACK
110 VOLT A.C. SUPPLY
TO SPEAKER TERMINALS ON RECEIVING SET

FIG. 5

A circuit for operating the auxiliary relay

On Short Waves

A Short-Wave Record?

From Mr. Arthur J. Green, of Klondyke, Ohio, comes a very complete list of foreign short-wave broadcast stations, received on his S.W. receiver:

LSH, Monte Grande, Argentina, 14.5; PMB, Bandoeng, Java, 14.5; DIV, Nauen, Germany, 14.6; DGW, Nauen, Germany, 14.83; LSG, Buenos Aires, Argentina, 15.02; DIH, Nauen, Germany, 15.02; DFA, Nauen, Germany, 15.29; FW, St. Assise, France, 15.43; FTM, St. Assise, France, 15.43; XDA, Chapultepec, Mexico, 15.9 and 31.8; PLE, Bandoeng, Java, 15.92; GBJ, England, 16.01; GBU, England, 16.11; PCK, Kootwijk, Holland, 16.3; GBS, England, 16.38; CGA, Drummondville, 16.5; GBW, England, 16.54; GBK, England, 16.57; FZU, Madagascar, 16.7; PLF, Bandoeng, Java, 16.8; PHI, Huizen, Holland, 16.88; HSIPJ, Bangkok, Siam, 16.9; PCL, Kootwijk, Holland, 18.07; GBX, England, 18.56; Saignon, Indo-China, 18.75; PLG, Bandoeng, Java, 18.80; Lyngby, Denmark, 19.6; LSJ, Monte Grande, Argentina, 20; VPD, Suva, Fiji Islands, 20.7 and 31.3; FW4, St. Assise, France, 24.4; KIXR, Manila, 24.4 and 26.2; 5SW, Chelmsford, England, 25.53; CJRX, Winnipeg, Can., 25.6; KIO, Hauhuhu, Oahii, Hawaii, 25.65; PHC-PHA, Nauen, Germany, 26.22; PLR, Bandoeng, Java, 27.8; VK2ME, Sydney, Australia, 28.5; VK2FC, Sydney, Australia, 28.5; ARI, Hongkong, China, 29.5; NRH, Heredia, Costa Rica, 30.8; LS, Monte Grande, Argentina, 30.9; FW, St. Assise, France, 31.2; VK2FC-ME, Sydney, Australia, 31.28; PCJ, Eindhoven, Holland, 31.3; Zeezen, Germany, 31.38; VK3ME, Melbourne, Australia, 31.56; Paris, France (experimental), 31.65; CJA, Drummondville, Can., 32; HKCJ, Manizales, Colombia, 35; WSBN, S.S. *Leviathan*, 35.5; 3KAA, Leningrad, Russia, 36; DOA, Cobeutz, Germany, 37.5; F8BZ, France, 38.5; VK6AG, Perth, Australia, 41.7; VRY, Georgetown, British Guiana, 43.86; ZL3CZ, Christchurch, New Zealand, 50; RA97, Khabarovsk, Siberia, 70.2.

Mr. Green's list includes short-wave stations in the four corners of the earth. It is, in our opinion, a noteworthy achievement. Does it constitute a record?—The Editors.

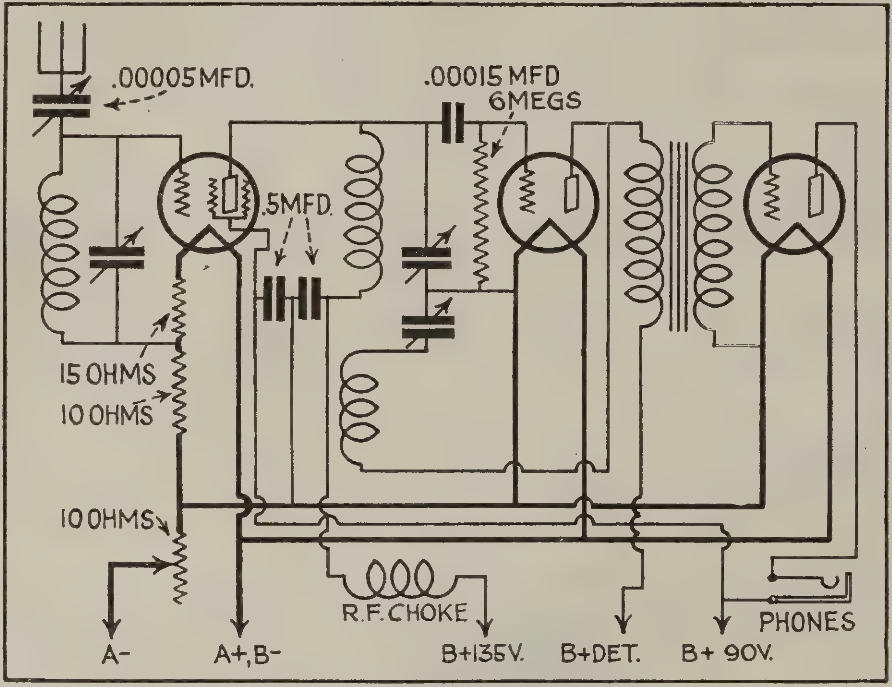


Fig. 1—Circuit showing addition of screen-grid tube to a two-tube short-wave receiver

Revamping the Regenerative Receiver

Along with a number of other short-wave fans, Mr. Dennis McGrath, of Buffalo, New York, had in his possession a short-wave receiver using a regenerative detector and one stage of audio. Believing that there were a number of short-wave signals on the air which he was unable to raise to a level sufficient to hear, Mr. McGrath determined to add a stage of radio-frequency amplification, using the battery-operated screen-grid tube. First experiments were carried on using this tube as a coupling tube between the antenna and detector. Such a circuit helped somewhat and eliminated the dead spots on the regeneration control caused by the antenna, but still the results were not as satisfactory as could be expected.

It was necessary, therefore, to start a second series of experiments, this time using the same type of tube in a tuned circuit. After employing various kinks and wrinkles, such a circuit as shown in Fig. 1 provided all that could be desired from a three-tube receiver. It was found, though, that the standard tuned radio-frequency circuits as used in a number of broadcast receivers was not suitable. Let us, therefore, just run through the circuit Fig. 1.

The .00005 mfd. variable condenser in series with the antenna and the grid circuit of the radio-frequency tube was found advantageous in that a regular broadcast antenna could be used and still retain the sharpness provided by the shorter antenna usually erected for short-wave reception and transmission. The 25-ohm resistor tapped at 10 and 15 ohms inserted in the negative leg of the filament circuit of the screen-grid tube reduced the 5-volt supply to the proper operating voltage of 3.3 as required by the –22 tube, as well as providing an automatic "C" bias of 1½ volts for the grid of this tube. Neither stable operation nor amplification could be obtained by using a plate coil separate from the grid coil in the detector stage, so the tuning inductance of the detector coil also served as the plate coil of the screen-grid tube, the grid of the detector, of course, being removed from the high plate voltage by the .00015 mfd. grid condenser. It was also found that by-pass condensers of .5 mfd. each were necessary in the screen-grid and plate circuits, as well as a radio-frequency choke coil of about 85 milhenries. These three units eliminated all tendency toward unstable operation. It will be noted in the circuit diagram that the grid return on the detector tube is made to the minus filament. This only holds true when the –00A tube is used. A plus return is correct when using the –01A or –12 type of tube in the detector stage of any receiver.

Clearing Up Audio Distortion

"Many times the short-wave enthusiast encounters a receiver which, when operated at fairly loud volume, will emit sounds not unlike those heard in a stockyard," writes Mr. D. A. Brown, Marion, Ohio.

"There are two or three causes for this nature of trouble: defective speaker; defective tubes; and improper grid bias or 'C' voltage. The latter is the most general cause and particularly in the case where a 'B' eliminator is used with dry batteries for the 'C' bias. The writer has been up against three or four cases where the receiver operated very efficiently in the daytime and at night the distortion was very annoying. The trouble was caused by the set being adjusted for biasing voltage when the alternating current line voltage was high, as in daytime, and when the night load was on the line the voltage dropped, causing a proportionate drop in the plate voltage furnished the receiver. The only way to remedy the trouble arising from this source is to arrange the 'C' bias voltage on the eliminator with the addition of an additional resistor and condenser.

(*Continued on page* 1042)

A Set-Tester De Luxe

(*Continued from page* 1017)

that was removed in the socket of the tester, giving it sufficient time to warm up if the tube is of the a.c. type. You will know approximately what the grid bias of the tube should be from its type. Set the voltmeter switch the next higher scale, and flip down the grid switch. This will give the bias voltage of the tube. Return the grid switch to its normal position. If the receiver under test is a battery receiver, place the voltmeter on the 15-volt scale and flip down the filament switch. If the tube is from an a.c. receiver, it will not be necessary to do this. Simply set the a.c. selector switch to the appropriate voltage and read directly from the a.c. meter. Return the filament switch to normal position. Next we have the plate voltage switch. This is operated just like the others, and the voltmeter must be on high scale. To obtain the plate milliamperes, leave the plate voltage switch down, and flip down the "MA" switch. As explained above, the milliamperes will be ten times the voltage scale. To test the tube, leave the milliampere reading on the scale and move the grid test switch over. This should result in a marked increase in reading on the scale. Move the voltmeter selector switch to the highest point in its arc, thus disconnecting the meter, and replace all switches in their normal positions. The instrument is now ready to go on to the next socket in the receiver.

In the interpretation of all of the above readings it is necessary to know approximately what all readings should be, since any marked deviation from normal in any reading should offer a clue as to where to look for trouble. Low, or no grid current probably indicates a broken filament lead. Abnormal or subnormal plate voltage will indicate run-down B batteries, or defective power supply. No reading at all will indicate an open primary in the succeeding transformer, open plate lead or defective power supply. High milliampere reading indicates a defective tube which should be discarded. No grid bias will give high milliamperes, but that should have been ascertained in the grid voltage test. Low milliamperes, when all other conditions are normal, indicate a tube that has lived its life of usefulness and should be discarded. Normal milliampere reading, but no change when the grid test switch is thrown over, also indicates a defective tube.

It will be noted that the leads of the milliammeter are brought out to the pin jacks on the panel. This is done so that the meter is available for outside tests. For instance, in lining up ganged condensers, this meter may be connected in series with the plate lead of the detector tube. In this case, the detector tube will act as a vacuum tube voltmeter, and the signal impressed on the grid will cause a deflection of the meter. In the case of a condenser and leak detector, this deflection will be downward. In a C bias detector it will be upward. Make any adjustments in the radio-frequency end of the set with a view to obtaining maximum deflection.

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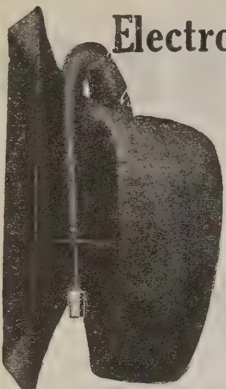

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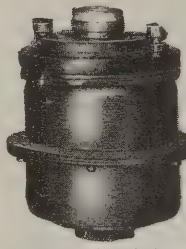

Racon Junior Electro-Dynamic Type Horn Unit Patented May 7, 1929

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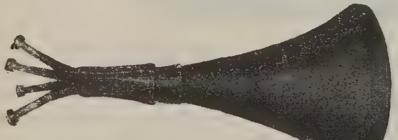

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Tying Up Radio with Sunspots

(*Continued from page 987*)

actual photograph of the sun and its spots. This is done daily at many large observatories, and the method is quite simple. The amateur may wish occasionally to photograph an important spot group, though the daily free-hand practice is quicker and cheaper. The very simplest means of projecting the image of the sun or any other bright object is to let it shine through a pinhole in a piece of cardboard. If a second screen is held a few feet beyond the first, an inverted image will be projected faintly upon it. To form a solar image of 3/8-inch diameter, the screens must be about three feet apart. A small double-convex lens will let in more light and give better definition than the pinhole, but it will not make the image any larger unless the screen is moved back. We do not want to move the screen back, as that would make the camera unwieldy; but by placing a double concave lens behind the double convex one and making in effect a Galilean telescope, we can get a reasonably large image within two or three feet. The focal length of the convex lens, divided by the focal length of the concave lens, gives the magnifying power, and as before, higher power means a larger image. Good focal lengths to start with would be about 10 inches (+4 diopters) for the convex lens and about 2 inches (—20 diopters) for the concave one. The concave lens or objective should be two or three inches in diameter; the other lens may be quite small. As the lenses are only a few dollars, and a black-lined box, shutter, and focusing screen can be made, a fair solar photographic telescope is within reach of the amateur.

Field Glasses May Be Used

For one already possessing good field glasses and a good camera, however, even less trouble is necessary. The photograph shows how the writer's 8x binoculars and Graflex 4 x 5 camera are lined up for solar photography, giving a 1¼-inch image with a double concave lens of 2-inch focal length in front of the camera lens. This arrangement is not limited to solar work—it will serve as a crude telephoto lens for general use. The double concave lens helps to increase the size of the image.

In addition to making his own observations, the serious experimenter will wish to check them by more accurate data. The solar constant is published daily on the large Washington weather map, which is mailed to subscribers for 25 cents a month or $2.50 per year. Monthly tables of sunspot numbers and of sunspot positions and areas are published about three months late in the Monthly Weather Review, which costs $1.50 per year. Both these publications are issued by the Government Printing Office in Washington.

Thus the observation limits of the amateur include ordinarily the larger sunspots for field glasses and faculæ as well as spot detail for a good telescope. Those who have time and money to build Hale's spectro-helioscope can see many other wonders of the sun—the leaping, flame-like prominences, the dark flocculi disappearing into the sunspot vortices, and the great hydrogen whirls of the vortices themselves. The corona, whose delicate, wide-spreading petals change with the sunspots and sometimes outline the sun's magnetic field, appears to layman and astronomer alike only during a total eclipse. To witness one of these awesome events the observer must pass within the moon's umbra or deepest shadow—a rare occurrence for most of us. The umbra will touch northern California and Nevada on April 28, 1930, and that same afternoon all the United States and Canada, being within the penumbra or outer shadow, will see a partial eclipse. For its next total eclipse the northeastern United States will have to wait until the summer of 1932.

How to Measure Signal Strength

With this discussion of solar disturbances and the methods of observing them we come to the end of our space for this month. Of all the various phenomena that a correlation study must include, the sun is probably the most important. Far distant though it is, within it probably lie the ultimate causes of all the earthly events that we are studying. Next month we shall tell how to observe some of the earthly events themselves—the various elements of the weather, the puzzle of magnetic activity, and the varying signals brought in by our radio receivers. The photograph shows one possible apparatus set-up for measuring the signal strength of a distant station. The Western Electric push-pull amplifier steps up output of either the short-wave set or the Radiola 20; and this audio-frequency current is rectified by the —50 tube, whose grid and plate are connected together. The milliammeter, being in series with the rectifier, gives a direct current reading proportional to the received signal. This is only one possible system out of many; the others must wait description until the next issue.

* * *

A Sea-Going Radiophone

(*Continued from page 989*)

and varied applications. While doing some experimental work in radio telephony on the Pennsylvania-New-York-harbor tugs for the DeForest company in 1919, the president of the railroad suggested possible communication between the caboose and locomotive of a long freight train. This seemed feasible but due to the lack of opportunity was not tried at the time. During the experimental period of the "trans-receiver" however, the chance presented itself and although the locomotive was operated by electricity no difficulty was experienced in talking to the crew in the caboose while the train was broken during switching operations a mile or more away.

Current Comment

(*Continued from page 993*)

Being interested in the speech of John J. Pelley, President of the New York, New Haven & Hartford Railway Company, at the Springfield Chamber of Commerce annual dinner, I tuned in on WBZ and clearly heard Mr. Pelley until he concluded, which was when I had reached the outskirts of Hartford, after passing through that city.

Then at eleven o'clock I tuned in on WJR, Detroit, getting their news flashes perfectly and also a musical program, the volume being so great that I reduced it for more comfortable hearing. The tone is excellent and the volume is more than amply abundant and without distortion.

From WJR I tuned in on WLW, Cincinnati, and had a like experience on volume. There I heard more orchestral selections and a piano solo. Then, rather liking Phil Spitalny's orchestra, I tuned in on him for the remaining fifteen miles or so into New Haven, Spitalny being on WEAF—and it was simply delightful.

For the first few miles I had an experience of fading, which baffled me until I discovered that it was not the set that was fading but that the apparent fading was due to passing over terrain of varying degrees of radio reception sensitivity and to, possibly, my rapidly changing direction, following the highway. Also, en route, I was able to discover what localities were free of local interference and those which were not, and, taken all in all, the Bosch Motor Car Radio set is a pretty good interference finder.

Here is another point of interest: Having been extremely active all day yesterday, I was quite fatigued last night when I left Springfield for New Haven. My experience was that the radio reception stimulated me and I scarcely realized the length of the trip, seventy miles. It seemed hardly any time before the lights of New Haven came into sight. In my opinion, I can operate an automobile just as efficiently with a radio turned on as when it is not. Bosch Motor Car Radio adds distinctly to my personal pleasure in motoring.

With kind regards,

Yours sincerely,
H. M. TOWER CORPORATION,
W. H. MILLER, President.

Globe-Trotting Television

A new record for television was established a short time ago when Dr. E. F. W. Alexanderson, research engineer of the General Electric Company, and associated engineers transmitted the image of a black rectangle thousand of miles through space to Wellington, New Zealand. It was there received and retransmitted to Dr. Alexanderson's laboratory in Schenectady, a round-trip total of 20,000 miles.

The picture transmitted was a rectangular design painted in black on a white card, and reception was sufficiently accurate to permit recognition of the original design. According to Dr. Alexanderson, "Considering the fact the picture bounded through the ether ripples twice

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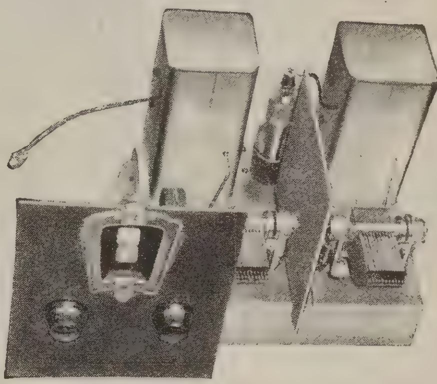

By ELECTRAD

Literally thousands of radio fans and experimenters have built the new direct-coupled amplifier designed by Loftin-White. And their enthusiasm is justified, for no radio development in recent years offers more interesting possibilities. Ordinary tuners, however, are not well-suited to the operating characteristics of the L-W Amplifier. So Electrad has designed a special Radio-frequency Tuner accurately adjusted to the exact requirements of the now-famous Electrad "A-245" L-W Amplifier designed several months ago in cooperation with the inventors. The Electrad tuner embodies two tuned stages, with one-dial operation, complete shielding, metal chassis, an efficient volume control, connections for antenna and ground and plug-in connector cable for all voltages and power supply. It may be placed over, under, or on either side of the amplifier and directly connected by cable.

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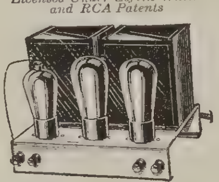

ELECTRAD LOFTIN-WHITE AMPLIFIER

Authorized by and prepared in cooperation with Edward Loftin and S. Young White, inventors. Provides assured performance of their amazing new direct-coupled system of audio amplification. Widens tone range and gets the most out of tubes without distortion.

Extremely simple to build. Kit includes all parts (*except tubes*) and assembly and operating instructions.

Imagine the great simplicity and efficiency this combination affords. Only four tubes (including rectifier) and delivering remarkable results. *Real* radio efficiency at a low price that appeals to every pocketbook.

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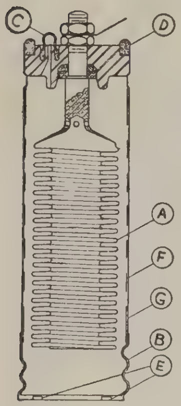
FOOL PROOF

CONDENSER PERFORMANCE



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C—Protected vent eliminating the possibility of damaging the nipple.

D—Pressure seal, with no possibility of cutting gasket.

E—Locking lugs in socket to prevent condenser shaking loose during shipment.

F—Shield, precluding possibility of internal short circuit.

G—Individual container allowing space to be utilized with maximum flexibility.

Individual cathodes eliminate all leakage between anodes and allow maximum flexibility in circuit design. Increased life, less leakage and much better shelf characteristics due to anode with edge effect of less than 10% of spiral type.

Leakage current guaranteed not to exceed .2 milliamperes per MFD at 400 volts after 5 minutes or .065 milliamperes per MFD at 350 volts after 5 minutes.

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Current Comment

(*Continued from page* 1037)

over so great a distance, I am very much enthused with the results of the experiment. I really did not believe the picture would be distinct enough to tell what it was because so many conditions existed to upset matters.

"There are ripples in the ether such as there might be in a pail of water. When one looks into a pail of water that has been caused to ripple, the reflected image is indistinct, the lines of the picture are exaggerated and made to appear somewhat fuzzy. In this rebroadcast it was much the same as though this image seen in one pail of rippled water had been reflected in still another pail of rippled water. Corresponding to the rebroadcast back from Australia, naturally there would be considerable distortion, and I am pleased this double distortion did not entirely wipe out the image. The experiment was carried on for about five minutes, and many times during this period the lines of the rectangle were distinct enough for observers to distinguish the picture being broadcast.

"The image would come in single design and would be quite clear for a period of time, then it would be doubled, tripled or quadrupled in some sort of cycle. It would end with a blur which would make the result indistinguishable, but would start over again as the cycle returned, to become recognizable once more. It was as though we were actually looking at the various paths the signals had taken, and we were watching them come into phase and step out again.

"By such experiments as this I am sure we can gain more actual knowledge of what does take place than with any purely aural system of check on the transmissions. A whole new front of attack on the long-distance short-wave problem is thus laid out by which much valuable information and data on the physical laws which govern such transmissions can be arrived at."

In the first experiment the tests were confined to the sending of the geometrical design. However, in the near future an attempt will be made to transmit actual figures.

Enter: The Professional Eliminator

There seems to be no limit to the offshoots from the radio industry, open to well-trained men.

Cities and towns troubled by interference from power-line leaks, street cars, arc lamps and electrical machinery of all kinds will be interested in the announcement of the Tobe Deutschmann Corporation of a radio engineering survey service, available by the day at a nominal charge.

The service includes locating and describing the cause of interference and, at the option of the client, the installation of preventive devices to permanently suppress the disturbances. Some of the towns which have been successfully served by this organization are Littleton, New Hampshire; Carbondale, Pennsylvania; Hartford, Connecticut, and Springfield, Vermont.

New Radio-Victor Building

Plans for a new skyscraper, to tower fifty stories high, at the corner of Fifty-first Street and Lexington Avenue, in New York City, have been announced. The plans call for completion by May, 1931.

The four faces of the building will reach upward for twenty-five stories, then set back at a slant to tower thirty stories higher and taper off at the top. The comparatively low height of the neighboring church and high school assures unobstructed sunlight and air on every side and makes possible architectural treatment that can be practically carried out on few office structures in the Grand Central zone.

Four gigantic stone figures, fifty feet in length and symbolic of the spirit of radio will front each side of the extreme top of the tower. At night an aura of colored light will shoot out from the crown of forked lightning which each figure will wear as a symbol of the speed of radio. The top of the tower, or the corona, will also be strikingly illuminated at night. The design of the entrance, the lobby and the rest of the building will carry out the same artistic motif representing the age of radio and electricity.

◆

Modern Miracles

(*Continued from page* 1015)

planned in advance with extreme care, checked hourly in each department, with inspectors and testers at hundreds of different stages in the making of each radio set, is the Grigsby-Grunow method. There are 13,000 employees, 1,300 inspectors and each Majestic represents 992 inspections.

Material flows through the eight plants in a steady stream, speedily—but not hurriedly. In the first two the radio set itself is made; in the next five, the cabinet, the speaker, while in the eighth 6,000 tubes are turned out daily.

There are no warehouses, and only a few relatively small stock rooms. In some cases material comes into the shops and within two hours is loaded on cars again in the form of completed radios, boxed for shipment. Practically no item is kept in an unfinished state more than two days.

About thirty-seven carloads of raw materials arrive daily. There is a standing order for forty empty box cars a day, to be switched in, ten at a time, into which radios are loaded the moment they are completed.

To build 5,000 complete radio receivers in an eight-hour working day is in itself a tremendous accomplishment. To build these same receivers at this great speed and with no sacrifice of quality is even a greater accomplishment.

Evolution of the Vacuum Tube

(*Continued from page 991*)

relicensee under the DeForest audion patents.

First Tubes on Laboratory Basis

Until the dawn of broadcasting vacuum tubes were made by means of more or less laboratory equipment. The relatively small volume of production could be cared for by glassblowers, with a minimum of machinery. The existing lamp-making machinery was found ample, particularly since the tolerances for vacuum tubes were fairly wide. The prices asked for vacuum tubes were such that they could be made piecemeal and without much regard for cost.

Now an Industry in Itself

But with the inauguration of broadcasting and the sudden demand for vacuum tubes by the public at large, the making of vacuum tubes became a real industry. No longer was it a question of supplying thousands of tubes. Rather, it was a matter of supplying millions of tubes to operate the sets in millions of homes. For the first year or two of broadcasting, there existed a marked shortage of tubes. There were times when list prices meant nothing as regards a maximum. Tubes actually sold at a premium, because of demand exceeding the supply.

Machine Production

By degrees, the radio tube industry geared itself to the demands. Automatic equipment was installed in the better plant. The skilled glassworker was replaced by the automatic machine, with its batteries of blue gas flames, its mechanical arms and fingers, and its constant merry-go-round operation for continuous production. Girl operators came into the industry, mounting and spot-welding the metal parts in place on the glass stem, and loading and unloading the automatic machines, followed by testing, inspection, wrapping and packaging. The greater accuracy of automatic machinery made possible closer tolerances, and more accurate tubes. If one will glance at an early DeForest audion, with elements spaced ¼ inch or more apart, and then at the first tube of early broadcasting days, and again at the present -27 heater type a. c. tube, one is immediately struck with the growing delicacy of vacuum tube construction.

Tube Makers Increasing

More and more vacuum tube makers have been attracted to the field during the past few years, until there are in the neighborhood of eighty tube manufacturers today. New, high-speed automatic equipment is imperative. No manufacturer can afford to use equipment even a few years old, and still remain in business. The tube industry is a big league game, and has no place for the smaller boys, now that inventive talent is being put to work on the production end. And for the public, it means better and cheaper tubes.

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in this small space!

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Not only small in size—the Mershon also has GREATER CAPACITY, less weight and gives no trouble. It is self-healing.

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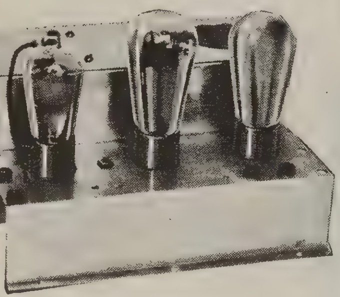

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Authorized and prepared in co-operation with Commander Loftin and S. Young White.

Build a complete receiver around the AMPLEX LW45 KIT, for its power supply is sufficient for one more '45 and four more '24 tubes. Or LOFTIN-WHITE any existing radio without rebuilding it, with the . . .

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Complete Kit . **$25.00**

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285 Madison Ave., (Suite 707) New York City

A Compact Auto-Radio Receiver

(*Continued from page* 1021)

the most effective results. This can be ascertained by starting the motor and tuning the set to the point where ignition noise is most objectionable and then note which terminal gives the best results. (This condenser should under no circumstances exceed .25 mfd. or hard starting will result.) The purpose of the resistors is to make the high-tension circuits of the car aperiodic to the frequencies within the broadcast range, and to dampen entirely the harmonics of these frequencies. Some cars will persist in giving disturbance even when treated as mentioned above; these can usually be cured by the use of a high-capacity electrolyte type condenser in the order of about 1,500 mfd. being placed from the hot side of the A battery at some point under the dash to the chassis. A little experimental work will show the best place for this condenser. Another but more expensive method is to place a choke like those used in A battery eliminators in series with the hot A battery lead going to the receiver and having a condenser as mentioned shunted from this lead on the set side of the choke to chassis. Sometimes the shielding of the battery cable with copper braid will be sufficient to eliminate the remainder of the ignition noise. It is desirable to take your A battery supply directly from the A battery and not from some point beneath the dash, as these leads contain a large percentage of high-tension energy picked up both inductively from the spark plug leads and from the primary circuit of the coil.

A receiver similar to the one about to be described has been placed on the market and operates with exceptionally fine results. It has been found that this receiver gives a selection of from ten to fifteen stations regardless of where the owner may drive the car and satisfactory distance reception has been reported to the writer by various users of these receivers. A circuit diagram of the receiver is shown in Fig. 9 and it will be noticed by the reader that the conventional neutrodyne circuit with a 200A detector tube circuit is the nucleus about which the receiver has been designed. A novel and very satisfactory method of placing the coils—so as not to utilize additional space in the receiver—can be seen by referring to Fig. 2, which is a photograph of the chassis. The functions of the tubes are, looking from right to left: the first three are radio-frequency amplifiers, the fourth a detector, the fifth is the output tube and the one directly in back of it is the first audio tube.

The receiver is controlled by two knobs placed on a panel with a pilot light and A battery fuse. See Fig. 8. One of these controls is connected to the receiver by a flexible coupling which can be obtained from your local speedometer dealer. This cable piece, when cut, will have two distinctly separate cables, one within the other. It will be necessary to solder or braze each end of the cable by the use of a heavy soldering iron and straight muriatic acid so as to make one solid cable. This control can be run—and has been run by the writer—distances up to eight feet in length, but the shorter and straighter the cable, the more efficient the tuning with less annoyance from backlash. The speedometer cable used is that having a diameter of .187 inches, although a quarter-inch cable is obtainable as well as several smaller ones from the same source of supply. This cable is not fastened directly to the condenser shaft, but to a small friction drive which engages with a stamped bakelite dial fastened to the condenser shaft, thus serving several purposes; first, giving us reduction ratio of 10½ to 1 for finer tuning; second, to hold the condenser rotors rigid so that the bumping of the car will not detune the receiver; third, as a medium through which the condenser tuning device may be electrically insulated from the condenser proper.

This remote control device is shown in detail in Fig. 5 and specifications for its construction are given in Fig. 10. It has been found advisable to place a piece of ordinary thin rubber hose over the tuning cable, as otherwise if the cable touches the metal of the car (although it is at the same potential) a rasping noise is produced when the receiver is being tuned.

The size of the receiver has been worked out so that practically any automobile installation can be made directly over the steering column. Refer to Fig. 1 for dimensions. I have found that there is less vibration in the steering column than in any other portion of the car. Thus mounting the receiver here provides greater protection and insures longer life to the tubes. The tube sockets, incidentally, are mounted with the aid of rubber grommets for further protection. Also the volume control is a rheostat controlling all tubes, permitting them to be burned at the lowest temperature for the volume desired. The writer has found that this method of volume control adds greatly to the life of the tubes. A piece of sponge rubber is placed in the top of the shielded cabinet to serve both as a medium for which the tubes may be held firmly in their sockets and as an additional prevention against the tubes going democratic. This sponge rubber may be seen in Fig. 4, which incidentally will give you a good idea of the shielding construction.

Constructional Details

The variable condenser should be prepared by cutting off the shaft so that it protrudes ¼ inch from the condenser shaft bushing. Then have it milled down to the largest square obtainable from the shaft. This square shaft should then be threaded up to within 1/16 inch of the shaft bearing, leaving a shoulder for the dial to rest against. The next step is to place the dial, which is made of 1/16-inch bakelite with a square hole at its center, on the shaft and tighten it there with a nut. The dial will never work loose, as the square hole takes up the strain and places none on the nut. The condenser should be insulated from the chassis only if the A+ is grounded on your particular car.

The Hammarlund 70 mmfd. neutrodons are used and should be prepared in the following manner: remove screw and place a piece of .01 India ruby mica under the top leaf of the condenser to afford protection against shorts due to jarring of the receiver.

By referring to Fig. 3 a good idea of the wiring of the receiver can be ascertained. Practically all of the wiring is done underneath the chassis, as shown.

The only parts common to the chassis are the .002 mfd. detector plate by-pass condenser, the low-potential end of the antenna coil primary and one side of the filament circuit. The latter will depend on the car in which the receiver is installed. If the A+ is grounded on the A battery, then ground this side of the filament circuit, and if the A— is grounded, then ground the negative side of the filament circuit.

The aerial lead is brought out through the rubber grommet where the cable emerges from the receiver and can be seen wound around the cable next to the male connector plug in Fig. 1.

If a condenser of capacity other than the one mentioned in this article is used it will be necessary to use a different number of secondary turns, which may be roughly computed by the use of the coil winding chart described in the September, 1929, and March, 1930, issues of RADIO NEWS.

The battery cable should be taped the full length of the cable to render it waterproof. It should enter the battery box through a rubber grommet.

The reader may be interested to know that in all of the receivers of the above-mentioned kind installed in automobiles, only one tube has been microphonic and only one tube has burned out for any reason whatsoever. (On this particular installation the set was mounted over the rear axle of the car and was subject to considerable abuse.)

It has been found that waterproofing of the set is a very important item and much thought along this line has been given the receiver. It will be noted that there are only two places in which water could possibly enter the chassis, one being at the remote control, which is backed by a waterproof felt washer, and the other where the connector cable emerges from the chassis through a tight-fitting rubber grommet. It is believed that further waterproofing is entirely unnecessary, as no trouble has been experienced from a chassis taken care of in this manner.

It will be noticed that no numbers have been placed on the tuning dial; these have been purposely omitted as it has been the writer's personal experience that one will unconsciously refer to these figures while driving even in congested traffic, and as to the results of such folly the writer need not go into details.

Several experimental trips to determine fading characteristics of the receiver were taken from Los Angeles to a point some hundred miles distant and a curve showing an average fading condition is shown in Fig. 6. The only time fading seemed serious was when crossing certain thoroughfares, and this was only momentary.

The audio-frequency end of the circuit has been purposely left as a low-gain circuit, as most of the ignition noise is

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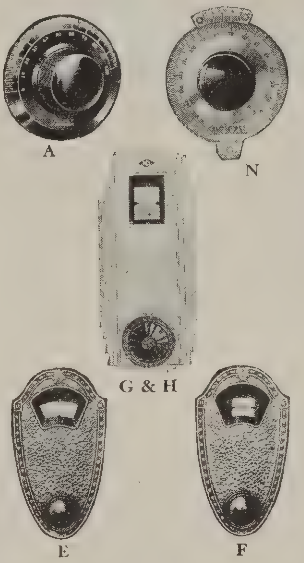

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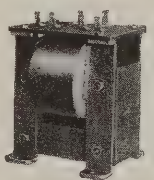

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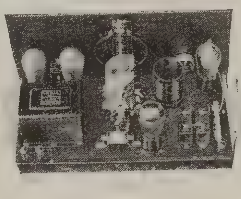

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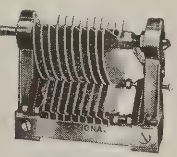

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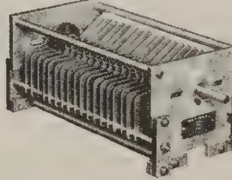

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picked up directly through the filament leads in the audio-frequency circuit; therefore, a high detector output and a low audio gain seems to give the most satisfactory results.

All wiring, other than the seven-conductor cable, speaker, and volume control leads, should be done with midget Packard cable or its equivalent; especially when strung beneath the chassis, as it is subjected to considerable abuse. Furthermore, it is desirable to run all wires through rubber grommets wherever possible to prevent the metal from scraping the insulation and causing short circuits or grounds.

If the reader will follow the pictures and diagrams very closely, a very satisfactory receiver, giving ample volume and good tone quality, should be his for the fruits of his labor.

Parts List

Shield and cabinet combined with lid and chassis.
1 4-gang variable condenser, .00035 mfd.
1 set of four radio-frequency coils
2 .5 mfd. by-pass condensers
1 .002 mfd. fixed condenser
1 .000125 mfd. fixed condenser
3 Hammarlund 70 mmfd. neutrodons or equivalent
6 Eby manufacturers type sockets (4-prong)
1 2 meg. grid leak
1 radio-frequency choke
2 audio-frequency transformers (Thordarson replacement type)
1 male 7-conductor plug
1 female 7-conductor plug
1 bakelite dial 3⅜″ diameter (see Fig. 10)
1 remote control friction reduction device and bearing (see Fig. 10)
10 to 13 ft. 7-conductor cable, depending on type of car and position of B battery compartment
26 ft. beeswax cotton-covered 7-strand tinned copper wire for hook-up
1 bakelite strip 5⅜″ by ½″ by 3/16″ thick for neutrodon mounting strip
1 bracket to hold cable in place
1 ½″ rubber grommet
12 small rubber grommets for socket supports
3 insulating bushings ½″ square and ⅝″ long, drilled for 8/32″ machine screw clearance
1 piece sponge rubber ¼″ thick by 2″ wide 35″ long for mounting between set and bracket and for use in shield (see Fig. 4)
1 piece .187 speedometer cable, length depending on individual installation
1 4-ohm rheostat
1 Yaxley pilot light and bulb
1 10-amp. fuse and clips

Radio Forum

(*Continued from page* 1034)

"But getting back to the original story, the sets troubled most with distortion are the battery models. With a milliammeter, used as an indicator of distortion, connected in the circuit, the short-wave fan can adjust the plate and grid voltages to suit the particular case, and the results will be very greatly appreciated by the owner.

"The indicating instrument for such defects as are mentioned above is the milliammeter. A reliable make of instrument with a scale of 0 to 50 milliamperes will serve the purpose very nicely.

"Connect it in the 'B' minus lead of the plate supply unit, then tune in on a fairly loud signal and note the deflection of the pointer. It will probably fluctuate violently when strong signals are tuned in. If the pointer pulsates from its normal position, there is too much 'C' bias and harmonics are being introduced, especially on notes of the higher frequencies, which will have a flattened or strangled sound.

"If this condition is found it is best to increase the plate voltage on the last tube, as this is where the distortion is most apt to be. With a given strength from the speaker, a reduction of the 'C' bias voltage will cause distortion and blasting, therefore, increase the plate voltage on the last tube until the pointer of the meter stands perfectly still, as complete stillness of the meter indicates absence of all distortion.

"It may be that when the plate voltage on the last tube is increased beyond a certain point the meter pointer will fluctuate both ways from normal settings. This indicates that the plate voltage on the tube preceding the last stage is not high enough, in which case increase the plate voltage on this circuit until an improvement is noted. The adjustment on the detector tube may be left alone, as the current is so small it has no effect.

"If, when the meter is first inserted in the circuit and a fairly loud signal tuned in, the pointer of the meter fluctuates violently downward, there is not enough 'C.' Increase the 'C' bias on the last tube until the pointer of the meter steadies.

"If the 'C' bias voltage is increased beyond a certain point, the needle of the meter will start to fluctuate both ways from the normal setting which it takes when a signal is being received. In this case increasing the 'C' bias on the preceding tubes will clear the trouble. With too little 'C' bias, the sound from the loud speaker is 'blasting' or a spilling over into distortion on the loud notes.

"In normal use, best results may be obtained from a receiver having a current drain between two to four—not over four—milliamperes for each of the radio and audio-frequency stages. The power output stage will take more, or less, depending upon the type of power tube used and the plate supply, usually the current load of such a stage will vary between five to fifteen milliamperes.

"The loudness of speech or music desired from the loud speaker determines the ratio of plate and 'C' bias voltages that are necessary to get distortionless reception. If fairly loud signals will suit the set owner, ninety volts for the plate supply will be enough, but to enable good hearing over the area covered by the average home, ninety volts will not be enough.

The Highroad to Adventure

(*Continued from page* 1013)

the radio operator consists of purely business and personal messages and securing of compass directions, there are times when it becomes intensely dramatic and the fate of hundreds of lives are in his hands. That is when a ship meets with disaster and his SOS goes out through the ether. It may be that his own ship is sinking and he alone can bring the badly needed help. The lives of a thousand may be within his keeping when all efforts of every other member of the crew would be in vain. Or, on the other hand, the call may come from another disabled ship and he must keep in touch with it until the rescue is made. And in every disaster that has occurred since radio operators first went to sea they have built up one of the finest traditions in the history of navigation, for no operator has ever left his key while there was the slightest possibility of maintaining communication.

The First SOS

The first radio operator to send out a call for help was Jack Binns of the *Republic,* which was rammed and sunk on January 23, 1909, by the *Florida.* Binns' call (it was a CQD at that time) was heard by several ships, which steamed to the aid of the doomed vessels but were unable to locate them because of an extremely dense fog which blanketed everything. As this was years before the radio compass had been invented and perfected, the skippers had to play a very dangerous game of blind man's buff. The sinking ship was finally located by the *Baltic,* by the discharge of bombs, Binns and the radio operator of the rescue ship calling to each other the exact times at which the bombs would be fired and the crews of each ship standing by to listen for the sound of the reports. The situation was growing desperate when the last bomb was about to be fired, but the explosion was heard by the keen ears of Binns and over three thousand lives were saved.

Since that time there has been a long list of equally dramatic rescues, and among the radio operators who stood by their keys while their ships were going to pieces is Fred Strickland of the freighter *Conhatta.* For three years following his completion of the radio operator's course at the West Side Y.M.C.A. in New York City, Strickland had an interesting time visiting many strange ports and enjoying his work.

A few weeks ago the freighter started out to secure a load of wood pulp from several ports in Finland. Helsingfors, Folkis and Kotka had been visited and she was making for the coast of Sweden, when extremely stormy weather was encountered, accompanied by heavy fog. Suddenly without warning there was an appalling crash and crunching and even a novice could tell that the ship had made her last trip. She had piled up on South Brotthl Rock and in an incredibly short time the angry seas had torn the vessel in two and the forward part had sunk. Almost with the crash Strickland began sending his SOS, and this he kept up until six hours later the *Herrakles* arrived

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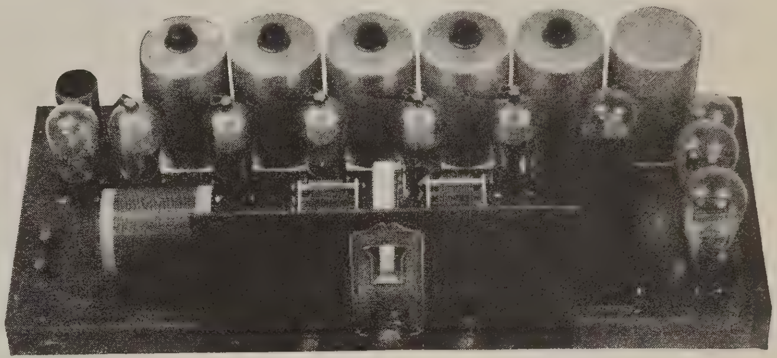

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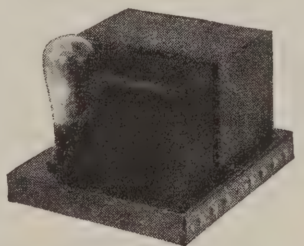
Nashville, Tenn.: Your Lincoln DeLuxe model is the only machine I have ever seen in this territory, being in the close proximity of from one to two and one-half miles of WSM, which would give an absolute 10 KC separation regardless of locals. Last night, Feb. the 21st, this machine consistently brought in WMAQ, WSM, and KFI. These stations as you know are 10 KC apart. This reception was perfect without interference, the distant stations coming in with equal volume and clearness as to locals. Should anyone wish proof of this statement, I will be pleased to demonstrate same.



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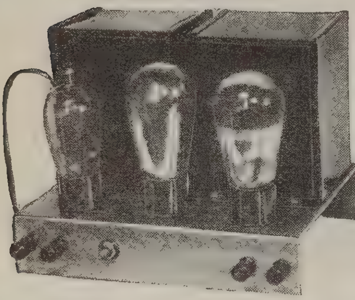

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and took off such part of the crew as she was able to carry. Strickland of course remained with the captain on board the stricken ship until a second rescue ship appeared, seven hours later, and took them off. Strickland is back at sea again, hoping that next time it will be his turn to answer a distress call and be the rescuer instead of the rescued.

Another West Side Y.M.C.A. graduate who figured in a recent marine rescue was Chief Radio Operator G. H. Kolbe of the *President Harding*. Early one morning Kolbe picked up the SOS from the Italian steamer *Antino,* which stated that the ship was sinking and help must come quickly. Captain Fried, of the *President Harding,* crowded on all speed and using the radio compass as his only guide was able to reach the *Antino* in time to make that thrilling rescue of the crew despite the heavy sea which was running at the time.

Radio Aloft

Radio is also being recognized more and more as a most important safety factor in the operation of airplanes and it will not be long until no passenger plane will make a flight of any distance without having a radio operator aboard. In this way the pilots can be continually informed regarding conditions of storm, wind and fog which lie across their path. When a pilot knows what weather conditions he is to meet, his chances of successfully surmounting them are greatly increased.

When it comes to the man who wishes to seek a career in the field of radio mechanics there is no limit to the variety of forms of endeavor into which he may go. In addition to finding a place with the transportation systems in the air, on the sea and on the ground, he has before him the equally large field of broadcasting, which in spite of the great progress already made is still in its infancy and presents opportunity for many a man to carve for himself a niche in the hall of fame, and a substantial fortune as well. Then there is the entire amusement world, with the talking pictures and sound effects in the theatre. Here too only a start has been made and there is plenty of room for great improvements which are sure to be found, many of them by men who are unknown in the profession at present.

It will not be long before no city police department will be considered really up to date unless it is radio equipped. Outstanding among the departments at the present time which keep in continual touch with their men throughout the city by radio are Indianapolis, Detroit, Cleveland and New York and the results obtained will force the other departments of the country to follow suit.

Still another field is the public address system which is rapidly finding a place in schools, hotels, railroad stations, public parks, auditoriums and churches. This is still a baby, awaiting many young men to grow with it.

The Man Higher Up

As to the third main classification, the field of the radio executive is so broad that it will challenge the imagination of anyone. These executives will be the men who will have the direction of forces so powerful that they cannot be comprehended by the average man. These executives must come from the younger men of the land, for they will need to be men whose minds are not fixed in the channels of the past but who are facing forward, ready to challenge the unknown. These executives will come from the ranks of the radio operators, the radio mechanics and the "hams," for they will have to be men who know radio from the ground up from practical experience. They will be men who have had a broad technical training in radio in addition to their own experimental work, for the man who has had this technical training can more easily fill the shoes of the radio executive.

The proof of the pudding is in the eating. The young men—many of them graduates of radio schools—of a few years ago are the supervisors, chief operators, engineers, designers, sales managers, advertising managers, public relations managers and the presidents and vice-presidents of the largest radio companies of today.

Need we say more?

◆

A Universal Auto-Receiver

(*Continued from page* 996)

The first step in the construction of the case is the cutting up of the aluminum to the sizes shown in the drawings, Figs. 5, 6 and 7. A thickness of 3/32″ is too great to be sheared with hand snips even in a metal as soft as aluminum. This limits us to a hack-saw or laying out the work and taking it to a machine shop where power shears are available. The job is a matter of a very few minutes' time in a well-equipped shop, but if we must employ the hack-saw method it will take a couple of hours.

With all six faces of the case cut and filed to dimensions, the four partitions are made in accordance with Fig. 6. It will be noted that two of them are bent 3/32-inch out of line to permit attaching to the ends of the triple unit condenser and yet maintain the proper separation from the other partitions. This is shown in the front view of the set. If it is found too difficult to make this double bend, there is the alternative of making the piece of two lapped sections held together with 6-32 machine screws and nuts. The notched corners are cut to fit in and around the angle brass of the case, one of the two having dimensions that allow for a number of wires to pass underneath.

The next step is to drill and countersink the various pieces. The drawings supply the location of each hole as well as the size of drill to be used. To make the drawings as clear as possible no sizes are shown for holes to be made with a No. 27 drill. This is the clearance size for the 6-32 screws. Before starting the

(*Continued on page* 1046)

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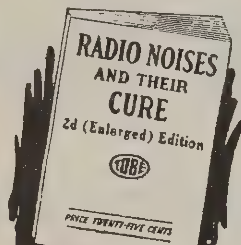

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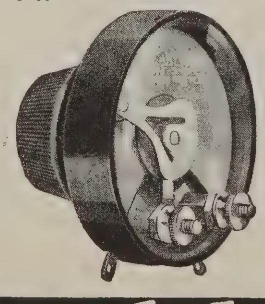

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drilling operation the builder should familiarize himself with the purpose of each hole and check the parts he has purchased to see if the mounting holes line up. This will guard against the improper location of any hole in a case where a unit may vary somewhat from the parts we used.

With holes drilled and countersunk, the next step is to cut the angle brass for the corners of our metal case. Four pieces are required with a length of 12¾ inches, four 9¼ inches, and four more 3⅜ inches long. Cut the ends squarely and remove any burrs with a mill file.

Line up one of the largest pieces flush with a long edge of one of the 10 by 13 aluminum panels, and through the countersunk holes mark the angle brass for its corresponding screw holes. For ease of assembly or disassembly, we use threaded holes in the angle brass rather than drill it clear for the 6–32 screws and employ nuts and lock-washers on the inside. Therefore, after the positions of the holes have been determined, use a No. 34 drill, and tap for a 6–32 thread. With flathead brass screws ¼-inch long, secure the four angle sections to each of the two largest aluminum pieces. Then place the 4⅛ by 10-inch panels in their proper positions over the ends of the 10 by 13's and mark the angle brass corners for the screws that are to hold them in place. By a similar procedure, secure the short angle sections across the flush with the ends of the aluminum pieces just added and then screw the top and bottom panels in place. True up the edges with a file and the metal box can be dismantled to the extent necessary for the convenient assembly of the electrical units.

Assembly

Remove the front and bottom panels from the case and mount the variable condenser to the top and back, as shown in the illustrations. It will be necessary to file the corners of the separating fins to fit around the angle brass. These condensers are built to permit mounting in either of two planes, but, since we are out to make a rugged job, we will use both. The unit is held to the top panel by three flat head screws, spring washers and nuts, and to the back by three 6–32 screws, which turn in to threaded holes in the frame.

Now fit the aluminum compartment partition to the condenser: I, to the outside left end of the frame; II, to the left-hand side of the web dividing the first and second units, to the right-hand side of the next section; and IV, to the outside right-hand end of the condenser frame. As soon as a good fit has been established, mark the condenser frame through the hole in each aluminum partition, carefully drill at the points indicated, and secure the plates by means of ⅜-inch 6–32 screws compression washers and nuts. It will not be found that this gives a 2½-inch separation between centers of the shields, and that the bottom ends are not notched deeply enough to clear the angle brass. That is as it should be, for we now notch the angle brass ⅛-inch deep to take the partitions, and to keep them from any sidewise movement. This method provides an effective means for holding the shields rigidly, and yet in a way that allows them to be taken out with the removal of a single screw.

While we have the interstage shields in place, with nothing else to interfere, it is a good time to form our tin inductance shields. As much as we would have liked to avoid the use of these pieces, we found, by experience, that they were absolutely essential to overcome coupling between the inductances. We cut the tin and bend it according to the drawings in Fig. 5, making three of each. Piece B is not put in place until after the inductances have been assembled and wired. With the A pieces formed and fitted between the partitions, and with their open ends downward, slide them until the top ends are 2⅞ inches down from the top panel. While held firmly in this position, mark them through the holes in the back of the case, and drill them with the No. 27 drill.

Now remove the aluminum shields and bottom section, and put the shields aside until the assembly and wiring are completed. A Remler radio-frequency choke is mounted in the upper left-hand corner of each inductance shield by means of a single flat head 6–32 screw and nut. The units are turned to vertical axes, with the mounting lug downward.

The radio-frequency transformers (shown in detail, Fig. 2) are secured in place, with their primary ends downward and separated from the shield by means of ¼-inch bushings. The coils are mounted at the angle shown for the purpose of minimizing interstage coupling.

The Yaxley single phone tip-jack is inserted in the hole for the antenna terminal in the left end of the case. The double resistor mount is attached to the back and against the angle-brass corner. These units require but a single screw. Under the nut, place a soldering lug turned toward the right. Adjacent to this, we mount an Aerovox type 260 condenser, with the lugs pointed to the left. In all of this assembly work, spring or compression washers should be used under nuts wherever possible.

Below each r.f. transformer, fasten a type 461-225 Aerovox condenser block, with the condenser lugs turned upward, and with added lugs placed under the upper and lower right-hand units used in making them fast to the case. Below each of these condenser blocks, add a type 260 Aerovox condenser, with the lugs pointed upward. These condensers have two holes in each mounting lug, but in every case we use the holes near the condenser and cut off the surplus metal.

The Thordarson output transformer is held in place by four ¼-inch machine screws and nuts in such a position that its output terminals turn downward. Below it we place the Aerovox double resistor mount, which carries a .006 mfd. coupling condenser in the hollow portion of its base. This is already connected to the proper clips, so we can forget it when once mounted. We place this unit with the "G" and "P" clips downward. This covers all of the units that are attached to the back of the case. The right end carries the Yaxley cable connector, with the guide pin toward the front of the instrument. The nickel-plated bracket that comes with this handy device is discarded, to permit the mounting of the little bakelite panel directly to the aluminum case. Include a soldering lug under the lower mounting screw and turn it to make contact with the side of the A circuit that is grounded in your car. Immediately above the multiple connector insert and secure the double phone tip jack.

We now turn our attention to the base section of the case which was removed when the assembly work began. To give ourselves plenty of room, we attach the various parts to it while it is separate from the main part of the set. It is found that the most direct connections result when the sockets are turned so as to bring the plate terminals in the rear right-hand corners. Using this position, secure the four Benjamin flexible sockets to the base, employing ¾-inch 6–32 flat head screws and nuts. The four-prong socket is placed at the extreme right. An Aerovox single resistor mount is fastened behind each of the sockets 2, 3 and 4. The mounts were originally intended to carry resistors to prevent r.f. currents in the screen-grid leads, and to cut the B+voltage down to the proper screen potential, but experience proved that the system did not function well at all. The resistors were replaced with National type 90 chokes, which are designed to fit resistor clips. But, because of the diameter of these inductances, there is not enough room between them and the base for a nut. To mount the units under these conditions, we tap the holes in the bakelite bases with an 8–32 thread, and secure them to the aluminum base by means of ½-inch 8–32 machine screws. Even with this treatment, it may be found necessary to file the end discs of the chokes slightly flat in one place, so that they can be pressed nearer the bases and thus get a better grip in the clips.

Back of the four-prong socket, we secure the remaining Remler choke coil, with its terminal facing forward. The filament resistances and the detector plate condenser are held in place by soldered connections, so we will delay their addition until they are reached in the wiring process.

Wiring

The wiring procedure is carried on in much the same order that the assembly was made. We first make connections from the upper or grid ends of the radio-frequency transformer secondaries to the stator plates of the condensers above them. Use the condenser lugs at the back for this purpose. The front stator lugs are employed for leads to the tube caps. The lugs placed under the central terminals of the large fixed condenser blocks are soldered to these terminals as a means of grounding the mid-points of the units. Each right-hand condenser lug is wired to the right-hand or B+ terminal of the transformer primary above it, and each conductor is carried on to its corresponding plate choke coil higher on the panel. A wire from the free side of the first choke is run downward and along under the inductances to

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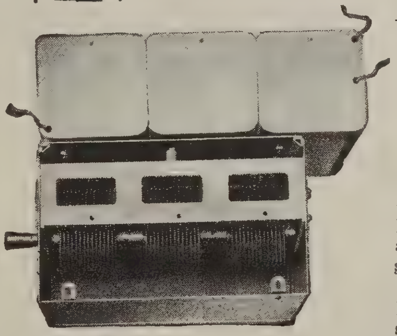

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the "B+AMP" pin of the cable plug. Shorter leads are carried from the other two chokes to this B+ bus conductor. The line is also tapped for supply to the battery side of the output transformer primary and to the "F" clip of the resistance coupling block below it. The last connection may seem wrong, but we find that it simplifies wiring to hook up the resistor mount in this way and correct the condition by interchanging the grid and plate resistors in the clips.

Going back to our condenser blocks we run a wire from each remaining connection to the center of the three inductance lugs above.

Now at the input end of the instrument we wire the antenna jack to the resistor clip nearest to it and also attach a 4-inch lead to carry the grid cap of the first tube. The lug grounded under the nut holding the resistor mount is soldered to the upper terminal of the .5 mfd. condenser, the lower connection going to the resistor clip nearest to it. The upper right-hand clip of the resistor mount is a terminal for a wire running across the set to the multiple connector pin surrounded by a green circle. This is the connection for one side of the volume control. Before making the conductor permanently fast, here the insulation in two places—one directly over the right-hand side of each of the first two double condenser blocks. These are to serve as contact places for screen-grid connections of the second and third tubes. Below the double condenser blocks we ground the right-hand lug of each .5 mfd. condenser to the lug under the nut immediately above.

At the output end of the set we connect the speaker terminals of the transformer to the lugs of the double phone-tip jack. The "B+" of the resistor coupling mount is wired to the connector-plug pin identified by a brown circle. This is the power tube C battery connection. Since all of the other points of contact lead to units on the base, we will next wire between those units, and finally join the base and back sections.

Occasional reference should also be made to the circuit diagram, Fig. 1. First mount the center-tap resistance on the third socket by soldering the lower lug to a bent-up heater lug. The 4-ohm resistance is set over a filament post of the last socket and held there by soldering a short, right-angle piece of bus bar from its lower lug to the socket lug underneath. Now the filament or heater circuit can be wired in accordance with the figures mentioned above. Leave plenty of wire for attaching both ends of this circuit to the cable-connector terminal pins. In connecting the filament posts to the A battery system, proceed very carefully, as it is easy to make an error that will seriously affect the grid potential of one or more tubes.

The .00015 mfd. moulded condenser is held in its vertical position through bending one of its lugs at right angles and clamping it under a nut on the plate binding post of the detector tube. A wire soldered to the top of the condenser is brought around to the cathode terminal of the same socket. By connecting the three screen-grid chokes and the detector plate chokes to the various sockets, we reach a point where the remaining leads are between the units on the base and rear panels.

Measure a wire to run from the negative terminal on the first socket to the lower left-hand clip of the double resistor mount. With the base in the same plane as the back, and edges even, run this connection beneath the socket and solder both ends. A shorter lead connects the screen-grid terminal of the same socket to the other of the two lower resistance clips, where one side of the .5 mfd. condenser has previously been attached. A lead from the plate terminal is run to the right until nearly even with the edge of the next socket, and then run upward and soldered to the left-hand primary lug of the first radio frequency transformer. The plate leads of the next two tubes take a similar course. Conductors are brought down from the lower ends of the transformer secondaries and soldered to the A battery system at points indicated in the illustrations. Short wires join the screen-grid terminals of the second, third and fourth sockets with the left-hand ends of the .5 mfd. condenser, which are used to by-pass the screen-grid supply. The right-hand ends of the choke coil mounts on the base have wires that lead upward, the first two joining the wire previously scraped to accommodate them, and the detector lead carried out to its own pin of the multiple plug.

The open end of the choke coil back of the power tube socket is wired to the "G" clip on the resistance coupling mount, while the terminal marked "P" goes to the grid of the last tube. The plate post of the four-prong socket is one end of a conductor that leads to the output transformer.

After all connections are made, check the soldered joints carefully, not only to see if the solder adheres well, but to make certain that no surplus solder has run down and grounded any part of the circuit to the metal case. It is also a good idea to compare the finished job with the wiring diagram while the joints are still accessible.

With the wiring completed, the base can now be turned up into position. This is done slowly while, at the same time in order to make a neat job, the wires joining the two panels are pressed back with a screw driver at points where they should bend. A little care in arranging these wires will be amply rewarded in the improved appearance of the set.

Just before the bottom is finally pressed into place, the partitions, or shields, should be re-inserted and made fast. The screen-grid and plate supply wires pass through the notches at the back of the shields, the plate leads from the sockets make use of the center bottom notch, while the A battery system runs through the forward corners. Secure the base with the brass machine screws, and slip the ends of tin pieces "B" of Fig. 5 between the pieces "A" and the aluminum partition. They are placed ½-inch down from the top and about ⅞-inch from the inductance. We left ours movable to obtain the best adjustment for maximum signal strength without oscillation, and then held them with a drop of solder between the two pieces.

A Heroic Rescue

(Continued from page 997)

the public had ever dreamed of hearing.

This was the story told by meagre wireless reports printed in the New York *Times* on April 15, 1912: "Cape Race, Newfoundland, Sunday night, April 14—At 10:25 o'clock tonight the White Star Line steamship *Titanic* called CQD to the Marconi wireless station here and reported having struck an iceberg. The steamship said that immediate assistance was needed.

"Half an hour afterward another message came reporting that they were sinking by the head and that women were being put off in the lifeboats. The weather was calm and clear, the *Titanic's* operator reported, and gave the position of the vessel as 41.46 north latitude and 50.14 west longitude.

"The Marconi station at Cape Race notified the Allan liner *Virginian*, the captain of which immediately advised that he was proceeding for the scene of the disaster. The *Virginian* at midnight was about 170 miles distant from the *Titanic* and expected to reach the vessel about 10 A. M. Monday.

"Monday, 2 A. M.—The *Olympic* at an early hour this (Monday) morning was in latitude 40.32 north and longitude 61.18 west. She was in direct communication with the *Titanic* and is now making all haste toward her. The steamship *Baltic* also reported herself as about 200 miles east of the *Titanic* and was making all possible speed toward her.

"The last signals from the *Titanic* were heard by the *Virginian* at 12:27 A. M. The wireless operator on the *Virginian* says these signals were blurred and ended abruptly."

This was the first word of the tragedy enacted in mid-ocean, but it was not until several days later that authentic news of how the accident occurred was received in New York. Only meagre reports reached shore ahead of the rescue ship and this was explained by Harold Bride, the *Titanic's* junior operator, who referred to his experience on board the rescue ship *Carpathia* after he had been taken off a life raft with his feet crushed and frozen.

Operator Bride said: "The public should not blame anybody because more wireless messages about disaster of the *Titanic* did not reach shore from *Carpathia.* I positively refused to send press dispatches because the bulk of personal messages with touching words of grief was so large."

When the ice patrol in the north Atlantic drops wreaths on the grave of the *Titanic* this April, as is the custom each year, it will be in tribute of the eighteenth anniversary of the disaster and the giant's calls for assistance which saved 705 lives. Both the CQD and SOS vibrated the ether upon the midnight clear of April 14 and 15, 1912. The *Titanic* sank at 2 A. M., on April 15, in 2,760 fathoms of water, 800 miles off the Grand Banks of Newfoundland.

When Captain E. J. Smith ordered Senior Operator Jack Phillips to broadcast the distress call, he flashed, "Come at once. We've struck a berg. It's a CQD, OM" (OM—Old Man). Junior Operator Bride suggested, "Send SOS;

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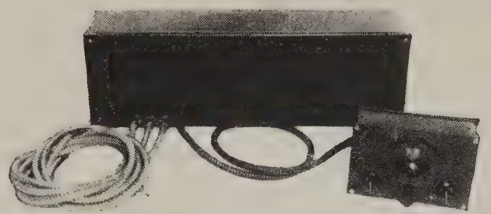

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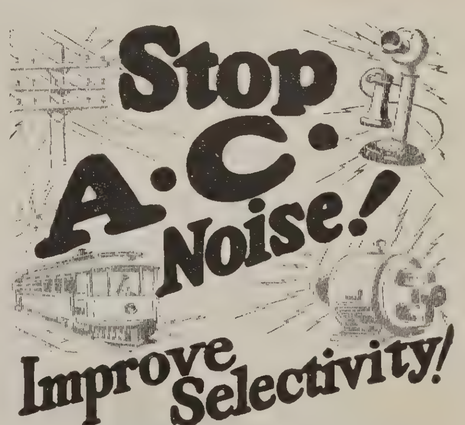

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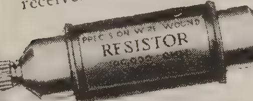

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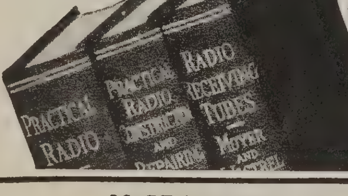

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it's a new signal and it may be your last chance to send it." So Phillips interspersed his CQD with the SOS. "CQD, SOS from MGY (call of the *Titanic*). We have struck iceberg. Sinking fast. Come to our assistance. Position, latitude 41.46 north, longitude 50.14 west, MGY."

Commercial land stations, numerous ships at sea and hundreds of amateurs tried and tried to reach the *Titanic* or ships rushing to her aid. That great confusion subsequently resulted from the jamming of the air with wireless messages in a frantic effort to get more news is evident from a dispatch of that day which reads:

"It was practically impossible to get any reliable information by wireless because of the great number of wireless stations breaking into the field and because of the work of the amateur operators. It appears that the disaster to the *Titanic* had no sooner been flashed over the seas than about every wireless instrument along the coast within range began to transmit with no thought of others, and so the net result soon became a hopeless jumble, from which distorted and inaccurate messages were patched up in haphazard fashion and announced to the anxious world.

"It is believed that this chaos was responsible for the messages that said the *Titanic* was en route for Halifax under her own steam at 6 o'clock at night, when, as a matter of fact, the vessel had been sixteen hours under the surface of the sea. This same chaos is held responsible for the reports that passengers were being calmly taken off the ship in the afternoon when the ship really went down at 2 o'clock in the morning of April 15."

Nevertheless, wireless aid, as crude as it was at that time, saved upward of 700 lives.

It was on April 11 that the rescue ship *Carpathia* under Captain Rostron sailed from New York for Gibraltar and Mediterranean ports. At 12:35 A. M. April 15, the wireless operator, Harold Cottam, told Captain Rostron that he had intercepted urgent distress calls radiated from the *Titanic*. Immediately the *Carpathia* was turned around. It was calculated that the *Titanic* was about fifty-eight miles away. Captain Rostron sent for the engineer and told him to call another watch of stokers and to make all speed ahead. The first officer was given orders to have the men stop all other work and prepare the lifeboats for instant service. The fifty-eight miles were covered in three hours and a half. At 4:10 A. M. the first lifeboat of the *Titanic* was was sighted and brought alongside. As dawn cast light upon the tragic spot other drifting boats were seen dotted on the waves.

Cottam, in the *Carpathia's* radio room, heard the call by just a twist of fate. He was about to retire when he went back to the receiver in hopes of picking up some news dispatches, but instead his earphones vibrated with the *Titanic's* plea for help. There was no other radio man on the *Carpathia*, because in those days it was not customary for a small boat to carry more than one operator. The *Carpathia* had a transmitter capable of covering about 100 miles and the *Titanic*, 450 miles.

Cottam later explained that he had closed the station for the night by cutting out the storage batteries, but this did not prevent him from sending or receiving. Then he began to go to his berth and had taken off his coat when he decided to tune in on the S.S. *Parisian*. He had the headphones on and called to her. The vessel did not answer but Cape Cod's spark cut in and the operator there took two or three messages. Then Cottam called the *Titanic* to ask if she knew that Cape Race had some messages on file for *Titanic* passengers. As he listened for a reply to his call he heard, "Come at once. This is a distress message, CQD."

The *Titanic* then called the *Frankfurt*, and the *Olympic* called the *Titanic*, but the latter's waves were too weak to span the distance to the *Olympic*. Cottam explained this later by saying, "There was too much rush of air and escaping steam. Then I heard the *Titanic* tell the *Olympic* to come at once, as she was going down by the head. The last message I received from the *Titanic* was, "Come quick. Our engine room is filling."

The S.S. *Birma*, which was 100 miles away from the *Titanic* when she sank, had changed its course and detoured around the icebergs, but when the *Birma* arrived on the spot the *Carpathia* signaled that she had picked up all survivors midst the bits of wreckage.

The *Virginian* also picked up the calls for help, but before she had dashed across the 162 miles in the direction of the floundered ship, the *Carpathia* told the captain that he might as well return to his northern track, because all survivors had been picked up. The dead numbered 1,635.

The *Baltic*, 200 miles east of the disaster, had detected the calls for help and immediately flashed that she was making all speed in the direction of the wreck. At 5 A.M. she resumed her course upon hearing that the Queen of the Atlantic had dipped beneath the waves at 2 A.M.

When he landed in New York, Harold Bride told the part that wireless played in the tragedy. He described how, after the jolt, Captain Smith put his head into the radio cabin and said, "We've struck an iceberg and I'm having an inspection made to tell what it has done to us. You had better get ready to send out a call for assistance. But don't send it until I tell you."

Ten minutes later he returned and said, "Send the call for assistance."

Phillips asked, "What call shall I send?"

"The regulation call for help," said Captain Smith. "Just that."

Phillips sent CQD and Bride said that they both joked as the call was broadcast.

Five minutes later the captain returned and said, "What call are you sending?"

"CQD," replied Phillips. It was then that Bride with a laugh suggested that Phillips try SOS, as it was a new call and it might be his last chance to send it. The operators shared the opinion of the marine architects and the passengers that the *Titanic*, the latest in ship design, could not be punctured and sent to the bottom of the Atlantic by an iceberg.

The ship began to have a forward list and as Phillips worked the key Bride strapped a life-belt on his back. A short time passed and the Captain returned to the wireless cabin and said, "Men, you have done your full duty. You can do no more. Abandon your cabin. Now it's every man for himself."

Phillips continued to talk with the *Carpathia*. Water was beginning to flow into the cabin. The operators left the wireless. Phillips ran aft and that was the last seen of him. Bride was picked up in the icy water by a lifeboat and taken to the *Carpathia's* hospital, where he remained for ten hours nursing his badly injured feet. Cottam, the *Carpathia's* operator, was becoming fatigued from the constant duty at the key, so Bride on crutches was taken to the wireless room to relieve Cottam. They both remained there until the ship docked in New York. As the rescue ship approached Sandy Hook the Marconi Company ordered its stations at South Wellsfleet, Cape Cod, Siasconsett, Mass., and at Sagaponeck, L. I., and Sea Gate to handle only traffic from that vessel.

During the years that have elapsed since the *Titanic* went down wireless has developed rapidly, and today most of the big liners have powerful vacuum-tube transmitters that span the Atlantic. Th
carry lifeboats equipped with broadca
ing installations, radiophone sets,
high-speed transmitters that handle
dreds of messages an hour, whereas
1912 all messages were sent by han
The old type of spark transmitter whi
the *Titanic* operators used to set t
ether in vibration is now obsolete, havi
been replaced by the vacuum tubes. Mos
of the ships now carry a radio compass,
or direction finder, and scattered along
the coast at strategic points are aut
matic radio beacons that flash characte
istic signals in much the same manner
a lighthouse flashes a beam of light.

Two definite developments in wirele
resulted from the *Titanic* tragedy. Firs
radio discipline and governmental contr
at a time of maritime disaster, and se
ond, the formation of an international i
patrol, resulting in the systematic guar
ing against the danger of floating ice
the lanes of transatlantic shipping.

Today an SOS stops all broadcast e
tertainment along the seaboard, but
the days of the *Titanic* there were
melodies or voices in the ether. In tho
days radio belonged to the sea!

Behold! The Decibel

(*Continued from page* 1011)

However, it must be remembered that where accuracy to several decimal places is essential, the formula and a table of logarithms should be used.

One's knowledge of the decibel is not complete without a set of working standards as to quantities. What does the decibel mean in terms of every-day, practical experience?

First, there is the matter of zero, or reference levels. In the field of sound, the level from which intensities are measured is the "threshold of audibility," representing the slightest sound that can be detected by the human ear. In electrical work, a power of .01 watt—the output of a standard telephone desk set—has been chosen. The gamut of electrical power is so great that we deal with many values far less than this amount as well as greater, and minus levels are frequently encountered — particularly in radio fields.

The range of hearing, from the threshold of audibility to the threshold of feeling—i.e., the point at which sound waves can be felt by the nerves of touch—is about 80 db. At this level, sounds are felt as well as heard. When the intensity rises to 120 db, the pressure waves become so strong that the sensation of pain is elicited. Common sound levels range from the whisper at 20 db, to ordinary conversation at 40 db and a yell at 50 db. Thus a range of 30 db is large enough to cover the ordinary requirements of dramatic expression, although the majority of broadcast transmitters can handle a much higher range, as wide as 80 db under favorable circumstances.

In the realm of sound motion pictures where the technician is called upon to record sounds of an infinite variety, ranging from heavy artillery fire to the still, small voice of conscience, a greater scope is needed than in the broadcast studi
where less attention is generally paid
sound effects. With the "light valve
method of recording, as used in the Wes
ern Electric system, 40 db is the norm
range, although this has been extende
under laboratory conditions to 60 d
The upper limit is set by the clashing (
a level of 10 db) of the two tiny metall
ribbons constituting the light valve; t
lower, by the "ground noise" or "surfa
noise" of the system, added to the noi
in the place where the sound is repr
duced.

In order to reduce the amount of e
traneous noise that gets onto the fil
sound recording stages are elaborately i
sulated against transmission of soun
from the outside. For example, some
the new stages on the Metro-Goldwy
Mayer lot are lined with a six-inch lay
of mineral wool. Recording machines a
floated on separated foundations and su
pended by sponge rubber or flexible su
ports. The loudest and most penetrati
noises, caused by trucks and tractors, a
about 65 to 70 db at 512 cycles. Insul
tion must reduce these sounds to ze
level, or at least to a value below t
average level of ground noises. Thus, i
sulation is conveniently rated in terms
decibels, according to the number of
it reduces the sound level.

It is perhaps interesting to note, by wa
of appreciating the marvelous adaptab
ity of the human hearing mechanism, th
the 120-db span between the threshold
hearing and the threshold of pain co
responds electrically to the ratio betwe
the output of a condenser microphone,
-60 db, and the output of a 10,000-wa
radio transmitter, at + 60 db. Th
range is about one and one-half to t
times the gain of an average modern
ceiver with several steps of r.f. and
good audio amplifier.

ews from the Manufacturers

(*Continued from page* 1030)

A Portable A.C. Operated Phonograph and Pick-Up

A recent announcement in the musical
eld is to the effect of a small portable
honograph with an electrical pick-up
operating on the usual a.c. electric light
outlet. This device, developed by the
tevens Manufacturing Corporation, em-
oys an electric motor for the turntable,
perating in conjunction with a small
ansformer and a special rectifier supply-
g a direct current of 4½ volts and a
rrent up to 180 milliamperes. A.C.
m has been entirely eliminated from
e entire assembly. The various com-
nents are mounted in a black leather
rrying case. The motor is suspended
springs directly under the turntable
hile the rectifier assembly is secured to
e base of the carrying case. An elec-
c phonograph pick-up of unusually good
aracteristics completes the apparatus
hich is capable of an exceptionally fine
production when employed in conjunc-
n with a satisfactory audio amplifier
d loud speaker.

n Aeroplane Dynamic Speaker

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r aerial advertising announcements has
en announced by the research labora-
ries of the Racon Electric Company.
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stinguish this horn from the ordinary
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ot's voice is distinctly audible while
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Analyzing the Hum

(*Continued from page* 1003)

extreme care in respect to induced hums. I recall one particular amplifier in a broadcast receiver which picked up and amplified into a loud hum the 60-cycle magnetic field of an alternating current soldering iron two feet away.

While the first audio transformer is naturally the most susceptible to these stray alternating magnetic fields, the second transformer must also be given some consideration. It must further be remembered that the electron streams in the tubes themselves are as susceptible to the magnetic fields produced by external sources as they are to the fields of the internal filament or heater, and must therefore not be unduly exposed to them, especially those tubes in the detector, first audio, and radio frequency stages.

Dynamic Speaker Fields

Not to be forgotten here is the electrodynamic speaker. The present speakers of this type, when supplied with unfiltered or poorly filtered field current, develop a strong hum caused by induction into the moving coil circuit of alternating currents produced by the alternating component of the field current. Also the speaker field coil and frame possess a strong a.c. leakage field under this condition and must therefore be kept at a safe distance or properly orientated with respect to those parts of the receiver which would be affected by such fields.

Separately excited speakers sometimes also develop hum caused by induction from the field magnetic circuit to the signal input transformer, or from the rectifier power transformer to the input transformer. I have in mind one of the most recent designs of an important dynamic speaker manufacturer in which this last condition was found in pronounced degree. The induction hum in dynamic speakers caused by the pulsating field current has in the past caused considerable hum trouble when used with receivers otherwise hum free. The usual methods of reducing this hum by bucking coils, shading rings, and condensers are not very satisfactory. Measurements which I have made indicate that the normal bucking coil will reduce the induced current in the moving coil system only to about one-third of its un-neutralized value; a heavy copper shading ring will reduce it to about one-half; a two-thousand microfarad condenser of the dry electrolytic type, in the case of a low-voltage rectifier type of field supply, will reduce it only about 30 per cent.

The writer has recently perfected a neutralizing method for this type of hum in dynamic speakers having a neutralizing factor of the order of 500. This will be described in detail at some future time.

Electrostatic Hum

Hum caused by induction of low frequency electrostatic fields arise almost wholly in the audio system, that is, in the detector and audio amplifier circuits. The radio circuits have very low audio frequency impedances from grid or plate leads of its tubes to ground, and therefore present practically no sensitivity to these fields.

Hum of this type occurs mostly at the higher audio frequencies because of the fact that given degrees of electrostatic coupling favor them. Any unshielded conductor carrying high alternating or pulsating voltage components may act as the source of these disturbing hums. Chief among these are the rectifier tube and its associated filament and plate supply circuits, the wiring and devices associated with the input side of the filter, and the primary circuit of the power transformer. These have pulsating or alternating voltage components of considerable magnitudes above ground potential, and therefore produce rather strong electrostatic fields. The rectifier circuits require particular attention, because of the rectifier tube distorting characteristic develops considerable voltages at higher audio frequencies, which are favored by the fixed electrostatic couplings and by the higher amplifying ability of the receiver.

Although gaseous type of rectifiers have been practically abandoned in present designs, it may be remembered that these usually introduce, in addition to those above mentioned, radio frequency disturbances capable of affecting the radio end of the receiver, and due care must therefore be exercised in their use with respect to this characteristic.

As with magnetic induction, the chief targets for the low frequency electrostatic fields lie in the detector and first audio stages. With the now customary grid detection, the grid of the detector tube, and the grid end of the grid leak and condenser connected to it, are separated from ground potential by very high audio frequency impedances, namely, the grid leak and condenser, so that these portions of the detector input circuit are highly susceptible to audio frequency electrostatic fields. Suffice it to state that a capacity of the order of one micromicrofarad between this grid input and the rectifier filament or plates or other of the previously mentioned sources, may cause an entirely objectionable hum to appear in the reproducer. I have in mind a broadcast receiver which had a very objectionable buzzy type of hum because the detector tube was mounted within a few inches of the rectifier tube.

To lesser degrees, the detector plate lead and first audio grid lead are also subject to this type of induction. The criterion of susceptibility of course, is the amount of amplification following the induction input point.

Heater Windings and Bad Filters

Unless the filament or heater windings of the audio or detector tubes are very close to ground potential, that is, with but little or no audio frequency impedance between them and ground, capacitative coupling between the rectifier windings and these filament windings in the

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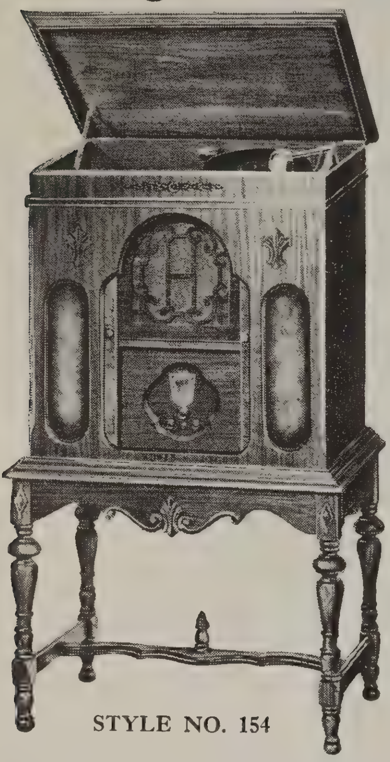

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power transformer may introduce hum, particularly in the detector stage. These tubes themselves are also influenced by these stray a.c. fields, both magnetic and electrostatic.

Omitting the filament supply current which has previously been discussed as a hum cause in receiver tubes, it is clear, I believe, that unsteady plate or grid voltages, caused by insufficiently filtered current supply, is a very common cause of hum in electric sets.

The current supplied to plate and grid circuits as a design problem, for most effective use of a given amount or cost of apparatus, has apparently not found its most effective solution in many receivers now available.

While not actually a part of the power supply apparatus, the filament or heater potentiometers may introduce hum-producing voltages in the grid or plate circuits of the receiver tubes, if improperly adjusted or fixed. While the early electric receivers were equipped with two or three variable filament potentiometers, the most recent tendency has been to use fixed potentiometers, or mid-tapped filament windings altogether. This is not advisable because of the variations in tubes respecting best adjustment of this potentiometer. This is especially true for detector tubes.

Extravagant Engineering

Some designers have used filter elements lavishly, in many cases, actually introducing hum by improper placement of by-pass condensers or use of improper circuits; others have succeeded in producing very quiet receivers with a smaller amount of hum eliminating apparatus, and also without impairing the fidelity characteristic of the receiver as a whole.

In developing the design of an electric receiver the designer usually proceeds with the best information at hand to make an operative assemblage of apparatus, and then, by cut-and-try or analysis methods, he corrects his circuit or layout, or choice of apparatus, until he is satisfied that, everything considered, the performance secured provides the best compromise between a number of diverging characteristics.

Because of the very complex nature of the hum problems in electric receivers, and the fact that most engineers in the past have concentrated their attention upon radio and audio frequency design, they have not been able to give the proper amount of consideration to hum problems.

Hum Diagnosis

It would appear, therefore, that a proper method of analysis by which the various hum causes may be searched out, identified, and measured, would be a very real assistance to such engineers, as these hums must be segregated and understood before intelligent steps to eliminate or mitigate them can be made.

To begin with, some form of equipment for measuring hum should be available. This is not nearly so easily realized as it might appear; since no particular method capable of yielding accurate results appears to have been generally adopted, a number of methods will be described along with their advantages and limitations. It is hoped that a satisfactory scheme may grow out of one of these and become standardized.

◆

Some Notes on the Practical Operation of Direct-Coupled Amplifiers

(*Continued from page* 1005)

radio-frequency amplification in a way that would permit the reader's continued use of apparatus already suggested, and in which he had probably invested, we were faced with limitations that curtailed, though not excessively, ultimate possibilities.

Since the radio receiver of the fourth article demands heavily upon the detection characteristics of the direct-coupled system, we think it appropriate to treat of the detection characteristics obtainable in one of our typical direct-coupled systems at this time. We do so with the aid of graphs obtained by actual measurement of the performance of the radio receiver described in our April (preceding) RADIO NEWS article.

In Fig. 1 Graph Eo is an input-output characteristic of the two-tube direct-coupled system of Fig. 1 of the April RADIO NEWS article in which the abscissæ represent the radio-frequency carrier RMS volts across the primary winding coupled to tunable circuit TC (usual antenna volts), and the ordinates represent the audio-frequency RMS volts across a 4,000-ohm non-inductive resistor in the output circuit of tube VT2. The particular radio-frequency carrier current employed for the making of Graph Eo was modulated 30% at 400 cycles. Graph Eo shows that once the lower knee is passed at approximately ten volts across the output element there persists substantially perfect linearity until audio overload of output tube VT2 is indicated by the upper knee of Graph Eo at seventy-five volts across the output element.

Thus throughout the very broad range of from ten volts output, representing about twenty-five milliwatts, at the lower knee across the output element, and seventy-five volts, representing about 1,500 milliwatts across the output element at the upper knee, more than the used operating range of such a system, there is had a so-called linear detection characteristic, a result seldom heretofore met with in practice.

The curvature at the upper end of Graph Eo is not due to discontinuance of detection linearity, but to audio overload of output tube VT2. In the system under investigation the detection linearity itself continues far beyond this point, which fact brings out that the substitution of a more powerful output tube than the –45 actually used would continue the linearity of Graph Eo far beyond that actually had in the particular investigation now reported.

Graph Ip in Fig. 1 shows, with the aid of the ordinates in microamperes at the right, the state of the plate current of input tube VT1 (–24) with variation of input carrier current. This graph shows that the plate current of VT1 remains substantially constant with change of input carrier current over a very wide range. The constancy thus shown in the matter of the plate current of VT1 emphasizes the effectiveness had in the stabilizing arrangement shown by us in the system of Fig. 1 of the April RADIO NEWS article.

Due to the automatic bias change with change of carrier current intensity obtained in the stabilizing arrangement, previously commented upon by us, the system will not draw grid current from tube VT1 until considerably overloaded by excessive input of carrier current.

The characteristics of the system shown by the graphs of Fig. 1 predict no modulation discrimination, and that such is true is shown by the one graph of Fig. 2. In Fig. 2 ordinates represent audio-frequency RMS volts across the 4,000-ohm output load previously mentioned, and abscissæ represent the percentage of modulation of a constant radio-frequency input potential at a fixed frequency of modulation. The graph is positively linear, showing that the output varies directly as the percentage of modulation.

The three graphs, E'_o, E''_o and E'''_o of Fig. 3 show the detection performance of the converted radio receiver of Fig. 2, described in the April RADIO NEWS article, for three different percentages of modulation of input radio-frequency carrier. Graph E'_o is the characteristic for a 70% modulation, Graph E''_o is the characteristic for a 30% modulation, and Graph E'''_o is the characteristic for a 3% modulation. These graphs show that the characteristic is linear for each one of these widely separated percentages of modulation. The 7% and 30% modulation graphs show that with these degrees of modulation the –45 output tube can be readily operated to full-load capability with reasonable degree of input radio-frequency carrier current before detection overloading is had, but that with 3% modulation considerable difficulty would be had at arriving at operation at full load of the output tube prior to detection overloading. Since 30% modulation is about as low as is employed in practical broadcasting, it is seen that the detection characteristics are well within the scope of usual practice.

The three resonance curves of Fig. 4 compare the input selectivity of the Loftin-White system used as a carrier current detector with the input selectivities of both so-called grid detection and plate or power detection. In other words, these curves compare the relative loading effects of the three foregoing types of detection systems on the output of the usual radio-frequency amplifiers preceding such detection systems.

The abscissæ of Fig. 4 show the curves taken at and on both sides of 1,000 kilocycles of input carrier current, the abscissæ at the right and left of the 1,000-kilocycle point expressing kilocycles. The ordinates express percentage of total response at and on both sides of resonance.

Curve 1 was had for the so-called grid type of detection, Curve 2 for the so-called plate type of detection, and Curve 3 for the Loftin-White type of detection. Comparison shows that the Loftin-White type of detection is more selective or, in other words, loads the output of the radio-frequency amplifier to less degree than the other two types.

Note is made of the fact that the showing of the three curves in Fig. 4 as having the same heights of peaks does not mean that they all have the same degree of so-called "resonant rise." They were simply drawn in this way to compare at and near the peaks the relative degrees of selectivity or loading effects. In fact, the Loftin-White curve has the highest resonant rise, as would be expected from the higher order of selectivity or less damping, the plate detection the next, and the grid detection the lowest.

We have heretofore referred to this low lamping effect of the Loftin-White system in cautioning that when an attempt is made to introduce radio-frequency amplification in advance of the system, caution must be had in the matter of adequate stabilizing against oscillation of the radio-frequency system because of the lesser loading tending to permit the radio-frequency system to more readily oscillate.

Book Review

Principles of Radio. By Keith Henney. John Wiley and Sons, New York. 477 pages. $3.50.

Mr. Henney states in his preface that this book "has been written for the man who must study without a teacher as well as for those who attend schools where courses in radio are given." He has succeeded in his purpose and produced a volume fitted to serve equally well as a textbook for the amateur and a reference book for the experienced radio man.

Beginning with a clear and simple discussion of the fundamentals of radio, a definition of common and essential terms, and an orderly introductory chapter, Mr. Henney goes on to discuss such subjects as measurement of antenna wavelengths, radio-frequency coils, antenna resistance, short-wave oscillators, the plotting and interpretation of regulation curves, instructions in the designing of an audio and a radio-frequency amplifier, and explanations of how to calculate reactance, impedance, capacity, etc.

The book is greatly enhanced in value by its many illustrations and diagrams, dealing in a practical manner with problems and examples in the values of electrical constants—such problems and examples as are encountered by the radio engineer.

The mathematics are simple of comprehension, but thorough and adequate in every respect to the problems with which they deal. Here is a book which should be welcomed by everyone who is interested in radio in any of its phases.

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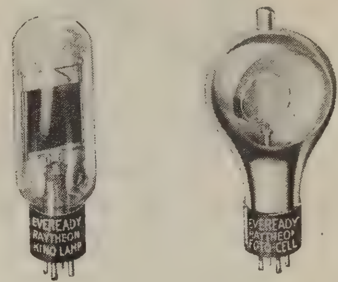

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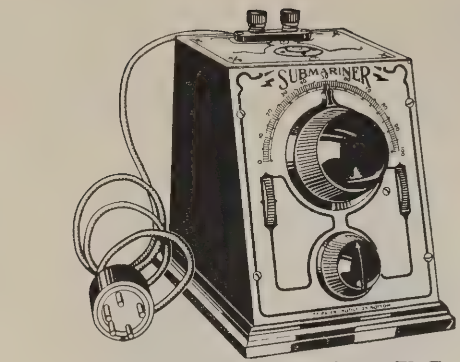

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A Review of Receiver Distortion

(*Continued from page* 1007)

that even the so-called linear detector only deviates from this law at high signal inputs, the second harmonic of the audio modulating voltage is introduced into and amplified by the audio amplifier just as though it were present before detection. However, normally this effect is not very noticeable, as most instruments contain the harmonics in their output and therefore the detector merely upsets the ratio of the strength of these harmonics to the fundamental frequency. Overloading of the detector has been another common source of distortion in the past, but recently design engineers have given more thought to this subject and, as a result, most of the later sets are quite free from detector overloading—unless, of course, the operator of the set improperly adjusts the volume level on a local station. Automatic volume controls, which endeavor to maintain a constant R.F. voltage at the detector input (for average values of modulation), are the real panacea for this trouble.

The audio system, unless no first stage is used, presents a real problem—not so much to the design man as to the cost department. Resistance coupling is, as a rule, more distortionless than transformer. However, the amount of the difference is proportional to the relative costs of transformers employed. Transformer is usually more stable in its operation—and allows a greater gain to be obtained. But then hum begins to be important, and as the detector is most often the primary source, it can easily be seen that the lower the gain after the detector—the lower the hum. That has been one of the major reasons for proceeding to the so-called power detection. However, power detection requires a higher radio frequency gain; which, in turn, requires more tuned circuits; which again brings in sideband cutting, high noise level and a tendency towards instability.

All audio systems attenuate the very high and the low frequencies, especially the low. Most systems have one or more peaks in the middle register. Good design tends to lessen the above effects, but they will always be present to some extent.

Unbalanced push-pull tubes lose all the good features of this type of circuit—although only a very few manufacturers arrange for their balancing by the consumer. This may lead the reader into believing that there is little or no chance of straightening out this "mess," but the writer will endeavor to demonstrate, below, how "happy mediums" can be reached.

This brings us to the loud speaker—and incidentally to one of the most abused units in the radio receiver. The dynamic type reproducer forms a mystical influence to the enjoyment of radio programs in the mind of the average person—and even in the mind of the average engineer. Several years ago this was to be expected, but since that date the public should have become cognizant of the fact that a loud speaker, of any type, lends no more or less to the natural overall reproduction of that which is impressed across the antenna-ground posts of the receiver than any other unit in the system.

All loud speakers give distorted outputs. Some have peaks; that is, they favor certain notes. These usually occur in the middle register, although some emphasize the bass. Others have depressions in their output. Most of them introduce harmonic distortion. These characteristics are common to all types of speakers; but this discussion pertains primarily to the electro-dynamic reproducer.

The scope of this article is such that the author does not feel that he can enter into all the details of distortion; he has merely endeavored to demonstrate that each unit in a radio receiver can and usually does introduce distortion. He will now give a demonstration of how the *overall* design eliminates, by compensation, the major changes in the signal caused by each separate unit. Of course, the curves are but indicative of the types —but not the order of the effects.

Fig. 1 shows a typical overall radio frequency selectivity curve, and a curve from an ideal receiver. As each broadcasting station covers or should cover 10 kilocycles of the radio spectrum, it can easily be seen that the typical curve discriminates in favor of the low notes.

Fig. 2 shows a detector response curve. Notice that at low signal levels (that is, working A and B) the output is not directly proportional to the input. At high signal levels (between C and D), and at low percentages of modulation, this particular detector would give quite an undistorted output. However, if the detector does distort the signal, there is really no compensation available, so that the desire for linearity of detector action becomes of obvious importance.

Fig. 3 is a typical audio response curve. The peaks have been slightly overemphasized to demonstrate the point. Fig. 4 is a dynamic speaker characteristic curve, showing marked humps at both low and high frequencies.

Even a casual glance at these figures (1, 2, 3 and 4) will convince the reader that marked distortion exists in the particular set depicted. Please reserve judgment—and study the overall curve on figure 5. Rather flat? A good receiver? Fidelity of reproduction? Yes, most certainly. But is the radio frequency unit distortionless? The audio, the speaker? Probably most people would call this a rather poor dynamic speaker. What does the receiver manufacturer think of it? That is the ideal speaker for his set!

So now, reader, will you reserve judgment on speakers, transformers, tuners, and detectors until you have examined the complete picture of these units combined? The insertion of the "X" speaker, or the "Y" transformer, or even the "Z" method of tuning will, as can easily be seen, ruin the flatness of the overall response curve of the hypothetical receiver demonstrated above.

Radio in Every Room

(*Continued from page* 1009)

consists of two general types. There is the type already mentioned, in which one or more central receiver-amplifiers provide the input for a system which includes loud speakers (or headphones) in every room. The second type of equipment consists of receivers which are loaned or rented to guests, and which operate from an antenna connection provided in each room or apartment, and draw their operating power from a convenient 110-volt wall outlet. The use of these individual receivers in rooms has been made highly practicable by two things. First, the development of receivers to operate from the house lighting supply has eliminated the battery troubles and has tended to make receivers fool-proof. Second, systems have been developed which will permit as many as eighty receivers to be operated from a single outdoor antenna. Therefore even the larger apartment hotels require only a few permanently installed antennæ on their roofs. A description of two such antenna systems was given in the article entitled "The Community Antenna," in the January, 1930, issue of RADIO NEWS.

The community antenna system is particularly practical in apartment hotels because it permits residents to use their own receivers if they wish, or if they do not possess receivers of their own, it is simply a matter of minutes for the management to install one of the "house" receivers. The simple procedure of carrying the receiver to an apartment and inserting the antenna and power plugs in a suitable radio convenience outlet plate in the wall completes the installation.

Central Amplifiers in General Use

For transient and commercial hotels the central receiver-amplifier system provides the most logical method of providing radio for guests. Equipment for this use has been developed to a high degree of excellence from the standpoints of both quality of reproduction and of convenience. Usually the central amplifier for each channel is mounted on a vertical steel rack about two feet wide by five feet in height, upon which space is provided for the receiver also, and even for an electric phonograph if recorded programs are to be used as well as radio programs. All of the central equipment is installed in some convenient room, usually either near the roof or in the basement.

Control of the equipment has been greatly simplified, so that in many hotels there is no need for an operator in constant attendance. About the only attention required is to see that volume is maintained at the proper level, which is accomplished by adjusting the volume control knob until the volume level meter on the panel indicates the proper level.

The network of wiring connecting the output of the central system to the individual rooms is necessarily a rather complicated one in a large hotel, especially as a pair of wires is carried to each room for each channel.

Wiring Well-Ordered

Except for the larger number of wires, the wiring system is much like that of the telephone network. In almost every case the radio wiring is carried in rigid metal conduit like that employed for the electric light wiring. This rigid conduit not only provides complete physical protection for the wiring, but also serves as an electro-magnetic shield to prevent pick-up of stray, parasite currents which might result in noise or hum.

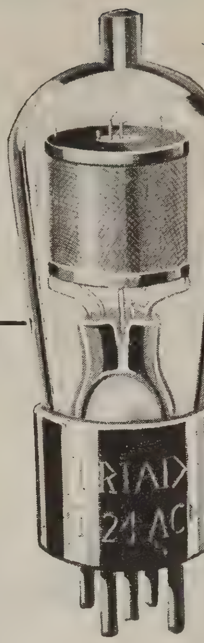
The wires ordinarily terminate at wall plates in each room. There must be some means provided to permit the guest to select the channel carrying the program which he prefers. In some cases, provision is made on the outlet plate, either by means of separate jacks for each channel, into any of which the speaker or headphones may be plugged; or the selector may take the form of a rotary switch. One of the latest units for room installation consists of a magnetic speaker enclosed in a metal box which is set into the wall with its grille front flush. On this front plate are the selector switch and a volume control. This arrangement simplifies the installation, inasmuch as it concentrates all equipment and wiring in a single unit.

A volume control in each room is a convenience. It is not an essential item, however, because volume is regulated at the amplifier to limit it to a level which will not penetrate the walls into adjoining rooms. The result is that maximum volume is never excessive, and for that reason many hotels do not include individual volume controls in their equipment.

Several Power Output Systems Available

Amplifier power is, of course, an extremely important consideration in hotel installations. An amplifier with an output stage consisting of a pair of –50 tubes in a push-pull circuit will operate approximately 200 of the magnetic type speakers used in hotels. Where more than 200 speakers are to be operated, additional push-pull output stages can be connected in parallel. If dynamic speakers are to be used in certain rooms, they will, of course, require greater power than with the magnetic type. A plan frequently followed where loud speakers are to be installed in some of the public rooms is to employ a separate output power stage to operate them. Where only headphone reception is provided a single push-pull type stage using –50 type tubes will operate up to 2,500 sets at comfortable volume.

The accompanying illustrations will be of interest to readers, as they show various types of equipment employed in hotel service. The schematic layout will be of interest to technically inclined readers because it shows most of the general details of a complete modern installation.



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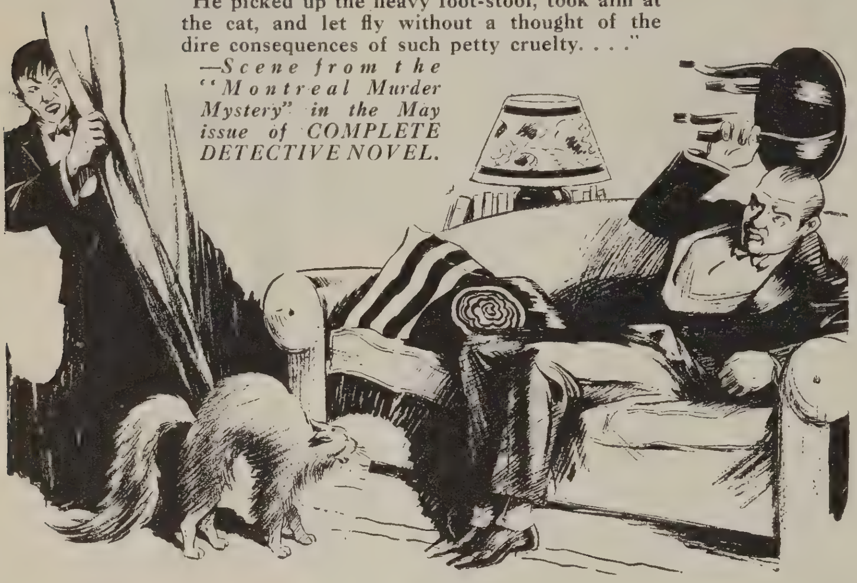

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Flying by Radio Beacon

(*Continued from page* 1014)

altitudes permits the air pilot to see great distances and follow his course by bearing upon visible objects. But in actual practice this, unfortunately, is not the case, and even in daylight flying across country, the airplane pilot is beset with difficulties. No two flights over the same route will be alike. He will encounter fog, rain, snow, sleet, smoke from forest fires and numerous other obscuring handicaps. At night his difficulties increase if poor visibility is encountered. Rapid and marvelous as the development of radio has been, there has never been a problem that presented greater ramifications than that of providing definite aids to aeronautical navigation, or one that offered so much reward and gratification in its solution.

Department of Commerce Sets Pace

The scientists and the radio engineers in the employ of our government, following the establishment by legislation of Federal regulation of aeronautics, were among the first to seek a practical solution of the problem of aerial navigation upon the established airways of the country. The Department of Commerce, through its Aeronautics Division, installed a system of lighting consisting of a flashing beacon approximately every ten miles with a lighted emergency landing field at every third beacon. In addition to this visual system, the Department is installing a chain of radio beacons and radio broadcasting stations for the distribution of weather information, throughout the United States. These radio beacons were designed to enable a pilot to hold his course irrespective of any side wind that would cause him to make leeway, and were first used by the Signal Corps of the United States Army to guide Lieutenants Maitland and Hegenberger upon their famous flight across the Pacific from San Francisco to the Hawaiian Islands. The system utilizes the directional characteristics of an antenna system of four sides from which, by the adjustment of a goniometer, signals may be radiated to any four points of the compass. The beacons generally in use (as this is written) are of the audible type, but experiments are being conducted with a method that permits the use of a visual type of indication.

Applying the Marine Radio Beacon

The comparatively short history of radio has been one of progressive improvement and, in the research looking toward perfection in methods for aeronautical navigation, radio engineers and research workers outside the government service, realizing the shortcomings of pioneer methods, began a study of the subject. Among the large number who turned their thoughts toward the solution of this problem was a small group of engineers in the employ of a company that had been very successful in the development and distribution of the marine radio compass. In attacking the problem these engineers realized that the final product must be simple in operation and provide visual indication. They kept in mind the increasing responsibility of the transport pilot and endeavored, as far as it was practicable, to provide an automatic device that would function definitely and surely and fill several needs. A long period of experimentation has finally resulted in the production of an aircraft radio compass that is a real step in providing a positive means of navigating an airship under any flying condition.

While the principles of the marine radio compass were generally utilized, the methods of operation were radically changed. It was impracticable, for instance, to use a rotating loop and, for equally obvious reasons, it was impossible to take the mean of two maximum signals, obtained by a rotating loop as in a marine compass, as the basis of computing a radio bearing. However, it was found, by using a fixed loop and taking into consideration the great speed and easy maneuverability of an airplane, that the airship could be used to rotate the loop fixed within it and the same result obtained. Instead of computing the mean of two maximum signals, the peak signal was utilized to denote a bearing upon the beacon.

In addition to the loop a small antenna was used. The shape of the antenna varies with the practical means of installing it and is determined by the type of airship upon which the apparatus is used. In the course of the air tests carried out with several different types of airplanes, it was found that a vertical antenna, a short trailing wire or a doublet all worked satisfactorily.

The Visual Indicator

The indicating device consists of a meter with a dial calibrated from zero in the center and similar in appearance to the ammeter on the dashboard of an automobile. However, instead of showing "charge" and "discharge" the aircraft compass indicator was labeled LEFT and RIGHT, or merely L O R, as shown in the accompanying illustration, respectively, as you face it. In practice, as the airplane is flying towards a beacon, the needle of the indicator would remain in the center, at zero, if the ship is on its course. Swing the ship to the right and the needle will point "left" on the dial, indicating that the beacon is then to the left of the pilot and that a left turn is necessary to bring the airplane back on her course. The opposite movement of the plane would reverse this indication. Careful tests disclosed the fact that this compass is accurate in its functioning to within a degree. To prevent oscillation of the needle of the meter due to vibration, it was found necessary to dampen its action, but this did not destroy sharp response to any change of direction. One old mail pilot who tested the compass complained that it "got his goat" trying to keep a sufficiently even course to keep the indicator needle at zero. His mind was relieved when he learned that few quartermasters of ocean liners are able to keep their vessels right on their compass course!

"Drift" Compensation

In theory, this compass had now reached the stage where its use would permit an airplane pilot to follow a radio beacon course to his destination, which we assume would be the locality of the transmitter upon which he was flying, regardless of the direction from which he was coming. By keeping the indicator on zero he would at all times be pointing his ship towards his goal. However, this very desirable feature was insufficient; there was still the matter of "drift," or "leeway," to be taken into account. With either a head or a tail wind he would be able to fly in a direct straight line towards the beacon, but with a side wind, at right angles, or any angle, to his course he would proceed in a crablike circle with the head of his ship pointing toward his destination, but his course would be a circular one, always down wind. It is true that he would eventually arrive at the beacon, but this leeway, unless corrected, would increase his time and mileage. Furthermore, if the country below was obscured it would be impossible for him to estimate which way he was drifting, there would be nothing in sight below upon which he could make an observation as to leeway. This was a serious drawback to the use of the compass and it appeared for quite some time that it would be impossible to remedy this objection. It was first thought that a simple system of triangulation based upon coordinating the radio compass course and the magnetic compass course would be a means of figuring drift, but this was quickly found impractical. The simplicity of operation would be complicated, and it was known that the action of an aircraft magnetic compass was both erratic and sluggish. Finally, more or less by chance, in working out another problem the solution to this one suggested itself. By utilizing the known characteristics of the loop antenna, a very serviceable compromise was arrived at. It is true that the degree of drift will not be accurately known, but a very close estimate can be determined and for all practical purposes the question of drift taken care of by a simple manual or mechanical change effected by means of a switch.

Hitting the Mark

Before the radio compass could be considered efficient from every angle, it was necessary to provide a means of informing the pilot whether or not he had passed over his objective beacon. If he had flown past it he would be following a "reciprocal" bearing and be proceeding in the opposite direction. In a marine compass this is taken care of by a unidirectional device. However, due to the tremendous speed of an airplane it was found that by the simple expedient of turning his ship for a few seconds at right angles to his course, the needle of the indicator would point to the direction in which the beacon lay. For instance, if the ship was turned suddenly to the right and the needle pointed to the left, it would be a positive indication that the beacon lay ahead. The pilot would then put his plane upon her course again. If the needle swung to the right with a right-hand turn of the ship, it would be just as sure an indication that he had passed his objective and that the beacon was behind him. This method obviates any ad

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ditional apparatus and is simplicity itself. It was thought, however, that some positive indication of the proximity of the beacon would be a very desirable feature and a small flashlight was installed in the indicating device and is adjustable so that it flashes on when the airplane comes within, say, five miles of the beacon, and remains lighted within that radius. It is a well-known phenomenon that there is a "dead spot" over a radio transmitter and that this could be used to inform the pilot of his arrival over his beacon. Exhaustive tests, however, proved that this form of indication was anything but positive in its action at all times.

The foregoing has been an attempted description of an aircraft radio compass that actual extensive air tests have shown to be a very desirable and reliable device. As an aid to air navigation it will fill a positive need. With it a pilot can be assured of following a radio course that will bring him to his destination regardless of drift. He will be given a fairly accurate estimate of his leeway and means of correcting it, and at the same time still be sure of his course.

In an early issue of this magazine a companion device to this compass will be described. It is an adaptation of the well-known characteristics of the radio beam. It takes the form of an airport "spotting" device, or flying field locater. It promises to be an invaluable aid to locating an airport in fog, snow, smoke or other obscurity. It is not claimed by the engineers responsible for its development that it will, in conjunction with the radio compass, solve the problem of "blind flying," but undoubtedly the two devices will add greatly to the ease and safety of flying in all conditions, night and day.

The following is a list of articles appearing in past issues of RADIO NEWS dealing with aircraft radio:

JULY, 1929—The Problems of Aircraft Radio, by Zeh Bouck; How Radio Serves Aviation Abroad, by W. Thompson Lees. AUGUST, 1929—Radio, the Graf Zeppelin's Only Contact with the World, by Lieut. T. G. W. Settle, U. S. N.; The War Correspondent Takes to the Air, by Zeh Bouck; The Realization of an Aviation-Radio Idea, by Lloyd Jacquet. DECEMBER, 1929—Hams Take Wings, by Ralph P. Worden. JANUARY, 1930—Radio—A Real Aid to Air Navigation, by Herbert Hoover, Jr.; Radio's Flying Salesroom, by A. Henry. FEBRUARY, 1930—Voices from the Clouds, by Robert Johnson; Radio Links the Americas, by Orrin E. Dunlap, Jr.; Flying Hams, by J. V. Magee. MARCH, 1930—How My Radio Helped Me Break the Transcontinental Air Record, by Capt. Frank M. Hawks. APRIL, 1930—Trail Blazing the Airways by Radio, by J. E. Smith.

◆

Putting the Spangenberg Transmitter on the Air

By LESTER W. SPANGENBERG, W2MB

SO great has been the interest in the duplication of the 200-watt crystal-control short-wave transmitter described in the November, 1929, and January and February, 1930, issues of RADIO NEWS *that Mr. Spangenberg has prepared the notes presented below, to aid those hams who have constructed this De Luxe transmitter in tuning it properly.*

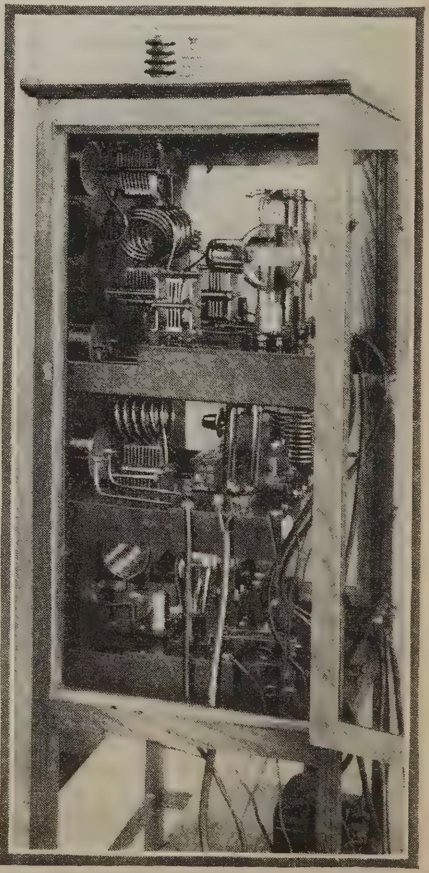
As Mr. Spangenberg concludes, "Judge for yourself what 2.5 amperes in the antenna will do for DX records!"

THE EDITORS.

AFTER the transmitter has been completed, and before applying the current, it would be a good plan to check over the wiring to make sure that it is properly wired.

In order to tune the transmitter in the proper way, a wavemeter, calibrated in the 3,500, 7,000 and 14,000 kc. bands, will be found to be a very handy instrument. In addition to this, a pick-up light, as we call it, consisting of a three-volt flashlight bulb, shunted by a single turn of No. 14 wire, about four inches in diameter, will prove very helpful in bringing the different stages to resonance. The proper way to handle this pick-up light is to hold the bulb in such a manner that the fingers touch only the glass part of the lamp.

The first step is to test the crystal at hand, to see if it will oscillate in the proper frequency band, namely, the 3,500 kc. band. This may be done by first disconnecting the high-voltage leads from the power panel, and removing the UX203A, and the two UX852 tubes. That will prevent the 7,000 kc. and the 14,000 kc. stages and also the power-amplifier stage from working. The current may now be applied to the crystal and the first frequency-doubler stage. Now rotate the crystal-stage controlling condenser until the ammeter in the tank circuit shows some current. A point will be reached where this current will rise to about 1.7 amperes, and then suddenly fall back to zero, as the condenser adjust-



Side view of Spangenberg transmitter

ment passes the resonance point. The proper adjustment of this condenser is just before the current takes the drop. As the 0-100 milliammeter is connected in series with the plate supply that feeds the crystal and the first frequency-doubler, the current will be about 90 mils. That is, when the two circuits are properly tuned. With this reading, the crystal stage will be drawing about 40 mils. and the first frequency-doubler will be drawing about 50 mils. Care should be be taken that these readings should not go higher. This may be governed by the proper adjustment of the controlling condensers and the "C" bias. The crystal stage requires 45 volts and the first frequency-doubler 135 volts. After this is accomplished, and to see if the crystal is working properly, a test can be made by touching the grid connection the crystal with your finger. If working properly, the crystal will stop oscillating and the ammeter reading drop to zero. Now remove the finger and if crystal resumes oscillation, and the meters show current as before and they remain steady, this stage is properly adjusted. The above adjustment, in regard to the grid connection in the first frequency-doubler, to the plate coil of the crystal stage, is obtained by putting this connection on the third turn in from the plate end of the coil.

The proper adjustment of the tuning condenser in the first frequency-doubler is reached when the plate current shows a "dip," and by the aid of the pick-up light, a point will be reached when the lamp glows brightest. This will indicate the proper adjustment of this stage. When using this pick-up light, care should be taken not to get too near to the plate coil, otherwise the lamp will burn out.

With everything working properly so far, the next step is to proceed in the tuning of the second frequency-doubler. The grid connection from the second frequency-doubler should now be connected to the plate coil of the first frequency-doubler, one turn in from the plate end of the coil. Now the UX203A and the two UX852 tubes should be inserted in their proper sockets. Connect the high-voltage leads from the power panel to this stage. Apply the filament current to this tube, and by means of the voltmeter in this circuit, see that the voltage is 10 volts. Make sure that the high-voltage leads from the power panel to the power amplifier are disconnected. Now by applying the current again, this will supply power to all of the tubes except the power amplifier tubes. In this hook-up, the power-amplifier tube filaments will be lighted, and by adjusting the rheostat in this circuit, to see that the voltage does not exceed ten volts, we are ready to tune the second frequency-doubler and neutralize the power amplifier. With the two grid leads of the power amplifier connected to the plate coil in the second frequency-doubler, one and one-half turns out each way from the center, we are ready to tune this circuit. With the pick-up light held about six inches from the coil, rotate the tuning condenser in this stage to a point where the lamp glows brightest, and the plate milliammeter will show a drop. At this point the circuits

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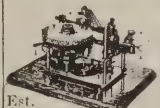
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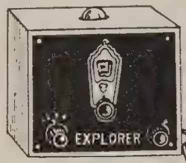

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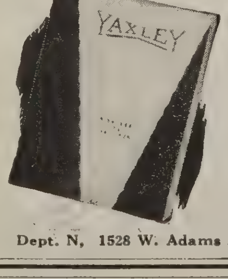

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are in resonance. The plate current should show about 60 mils. This can be accomplished by adjustment of the condenser and a bias of 225 volts.

The next step is to neutralize the power amplifier. First, have the antenna feeders disconnected and the two neutralizing condensers set at zero. Then, again applying the current, and with the aid of the pick-up light, tune the 14,000 kc. power amplifier tuning condenser until the light, held about six inches from the coil, glows brightest. Now with the pick-up light still in the field of the coil and burning brightly, adjust the neutralizing condensers, keeping them both about the same. This must be done carefully, for as you rotate them, a point will be reached where the light goes out. Now readjust the tuning condenser slightly, to see if the light again glows. If not we will assume the power amplifier tubes are neutralized. Now we have the circuits so tuned that we may connect the high voltage from the power panel to the power amplifier, and also connect the antenna feeders to the transmitter, through the proper feeder condensers. With the current again applied and the antenna feeder condensers about half in, and when pressing the key, some current should be shown in the antenna ammeters. By further adjustment of these condensers, you will be able to bring the feeder circuit to resonance. This point is reached when the maximum current is shown in the antenna ammeters.

The following is what we may expect to get in the different circuits: All filament circuits adjusted to their proper voltages, the current in the plate circuits of the crystal stage and first frequency-doubler will be about 90 mils, putting 1.7 amperes in the tank circuit of the crystal stage. The second frequency-doubler will draw about 60 mils. in the plate circuit, and the power amplifier will draw about 225 mils. With these readings there will be about 2.5 amperes in the feeders. Judge for yourself what 2.5 amperes in the feeders, in the 14,000 kc. band, will do for DX records!

◆

Weather Reports for Airmen

The Department of Commerce, by way of establishing an aviation weather reporting service, now has in operation twenty-four 2-kilowatt radio ground stations located along the national air routes, and fifteen more stations are in process of construction. When these stations are completed, they will provide every section of the United States in which regular flying takes place with half-hourly weather reports, as well as with a communication service. Inasmuch as these stations are placed at approximately 200-mile intervals along the airways, while there are hundreds of airports not located along the national air routes, much still remains to be done by way of providing two-way communication facilities for air transport pilots.

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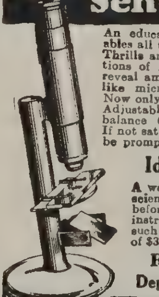

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Using the New Vacuum Tube Voltmeter

(*Continued from page* 1023)

Set Balancing for Servicemen

With the set connected to the voltmeter as in Fig. 7, the system becomes the finest hook-up for resonating the different stages of a multi-stage tuner. A station is tuned in. It does not matter in the slightest whether the program consists of a band, singer, or talk on prohibition; they all look alike to the voltmeter. With the station tuned in, the condensers of each stage are slowly rotated one at a time, until the highest reading is obtained, thus indicating that all the tuned circuits are "peaked." It will surprise many servicemen to see how exceedingly sharp and sure this method really is in operation.

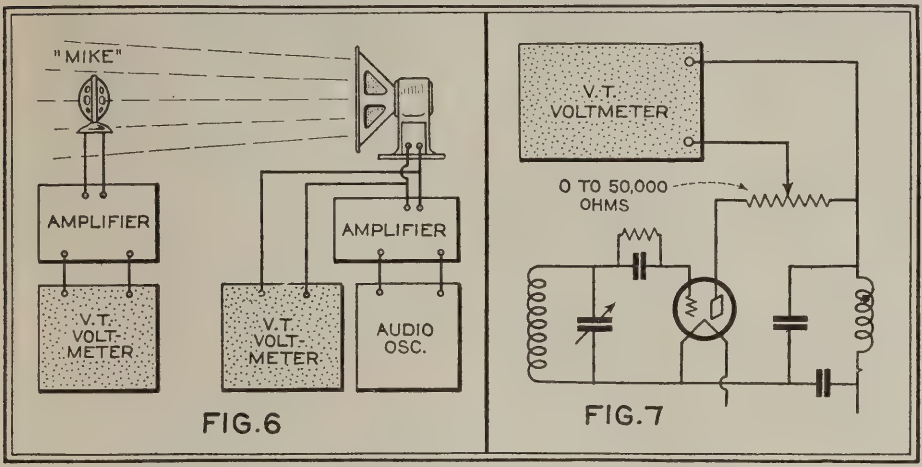

Fig. 6—The circuit arrangement for obtaining the performance curve of a loud speaker. A single vacuum tube voltmeter with suitable throw-over switching arrangement might be substituted for the second vacuum tube voltmeter, thus simplifying the set-up. Fig. 7—Using the vacuum tube voltmeter to resonate radio-frequency stages

Junior Radio Guild

The How and Why of B-Power Units

Lesson Number Ten

(*Continued from page* 1025)

placing our oscillograph at the tail end of the entire set-up.

Remember that the condensers store up and discharge the varying current which is fed to it to produce the curve as shown in Fig. 7. Now the addition of the two chokes further smooths out the current.

The choke coils, composed of many turns of wire wound on iron cores, have the property of impeding the flow of alternating or pulsating current while only offering a very slight resistance to the flow of pure direct current. Thus, when the output of the rectifier, as indicated by the wave form shown in Fig. 7, is fed to the chokes they exert a smoothing-out influence, flattening out the bumps in the curve to produce a steady, pure direct current, as indicated in Fig. 9.

In place of the oscillator we can attach a voltage-dividing resistance which will allow us to pick off voltages ranging from zero volts to the full output of the entire "B" power supply unit.

So, by the use of a unit which first steps up the line voltage, then rectifies it and finally smooths out the ripples, we have changed a.c. to d.c.

Radio Manufacturing Standards Revised

Promulgation of revised manufacturing standards for the radio industry is being planned by the Radio Manufacturers Association within a few months. This will be the first comprehensive revision of commercial standards in radio since 1928 and will bring manufacturing recommendations up to date. The revised standards, it is expected, will be issued by the Radio Manufacturers Association some time during May.

Ray H. Manson, of Rochester, N. Y., is chairman of the R. M. A. Standards Section.

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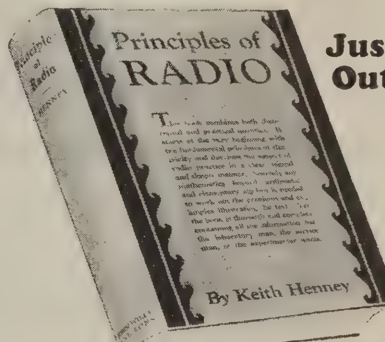

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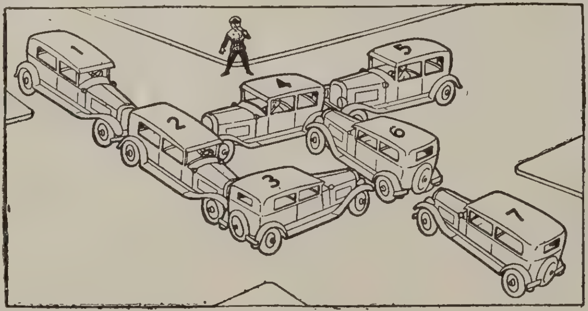

In the picture there are 7 cars in a bad traffic jam. None of them can move forward, for each car is blocked by the one in front of it. One of these cars will have to be backed out. Which one? The traffic policeman seems to be stumped. Can you straighten up this tangle for him? Only one car may be moved backward, and if you pick out the right one, you will see that it is not necessary to back up any of the others. Send the number of the car which when backed out will relieve this traffic tie-up, and if your answer is correct you will be qualified for this opportunity.

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ARTHUR MESKE Dept. 13, 510 N. Dearborn St., Chicago, Ill.

Brickbats and Bouquets

(*Continued from page* 1018)

tween 600 and 2,400 meters) and a 2 k.w. spark transmitter was used on 600 and 756 meters. At times NBD also remotely controlled the powerful NSS arc set at Annapolis, Md., quite some distance for remote control in those days. All of the above was pressed into use both day and night in the fall of 1918 to assist communication and message clearing with the seemingly steady line of home-bound ships.

Tremendous Volume of Traffic

There were some days I will long remember when our traffic sheets showed an average of 90 messages an hour received over a period of twenty-four hours. This of course seems unreasonable, but a good portion of this may be due to the customary abbreviations made in the text of messages, some of which were nothing short of the old Phillips Code. I know of times when the total traffic handled by NBD was greater than the average of 90 messages an hour, and when three operators were on watch at a time, but this was not averaged more than a period of a few hours a day.

I know truthfully that a great many operators of those days will recall the times of when I speak and realize these are facts and not exaggerations. Let a ship operator send to a land station message after message, using a fair amount of abbreviated text, hour after hour, and see for himself what his average will be for a period of twenty-four hours; the necessary shifting operators every four or six hours—even, as was the case in some instances, with operators changing every fifteen or twenty minutes.

There were times when the S. S. *Leviathan*, S. S. *Agamemnon*, S. S. *Von Steuben*, S. S. *George Washington*, S. S. *Kaiser Agusta Victoria*, and the S. S. *Berengaria* were all being cleared at the same time, and the message totals ran well over the 2,000 mark. This does not take into consideration the amount of traffic from shore to ship, coded traffic, orders for stores and stevedores and what not.

Conditions Much Worse Then

The question of congestion or interference is another consideration. I doubt if any of the present generation of operators could realize or visualize what it must have been when decrement meant something to a signal, before the days of short-wave phenomenal distance transmission. It was at that time impossible with accuracy to copy traffic from a ship much more than half the distance across the Atlantic, compared to the conditions at the present time.

It is now a common occurrence for vessels of the larger type, equipped with continuous wave on 2,200 meters to remain in touch with either side of the Atlantic until arrival at port.

Let us not forget at least the memories of those days mingled with pleasant and saddened thoughts. Radio played its role then and played it most graciously, and a lot of us will remember HOW.

Miami Beach, Fla.

Yours truly,
L. E. DUTTON,
Station WIOD.

Radio Talkies—The Next Step

Due to the modest amount of detail obtained with present television methods, it seems certain that radio television will be accompanied by synchronized voice or music, thereby obtaining what may be termed "radio talkies." The relatively perfect sound accompaniment must go far towards preventing the audience from concentrating on the pictures themselves, and also in explaining the action so as to make the story more enjoyable.

At least such is the opinion of J. E. Smith, president of the National Radio Institute of Washington, D. C. "It is relatively simple," states Mr. Smith, "to provide radio talkies. The sound accompaniment may be transmitted over any broadcasting station, while the radiovision signals may be transmitted by a television transmitter. Working from actual subjects or again from sound pictures, the picture signals are transmitted on the radiovision short waves, and the sound signals on broadcast waves. At the receiving end, a standard broadcast receiver tunes in the sound accompaniment, while a short-wave receiver and radiovisor handle the pictures.

"But for the ingenious combination of sound and picture signals, I do not believe that radiovision programs would have much entertainment value, once the first curiosity of the public were satisfied. However, as radio talkies, the attraction is certain to last until such time as a better radiovision technique is forthcoming."

◆

Is DX Radio a Lost Art?

Why don't we tune in stations a thousand or two miles away, as in the old days? That question is frequently asked by those possessing the latest types of all-electric radio sets.

The present-day radio receivers, sensitive as they are, are not primarily intended for long-distance reception. The increased power of broadcasting stations, together with the congestion of the broadcast air, has caused set designers to aim rather towards increased selectivity, volume and tone, depending on considerable signal input. Furthermore, the simplicity of present-day radio sets, calling for a gang tuning condenser, militates against extreme sensitivity.

In actual production, the gang condensers are matched as closely as possible, usually at the high, medium and low frequencies covered. However, it is physically impossible to have several condensers in a gang remain in positive electrical step. Invariably the condensers will fall out of step, resulting in reduced efficiency.

In remote sections skilled radio servicemen are taking standard broadcast receivers and providing them with supplementary or vernier condensers, connected across each condenser of the gang, for precise tuning. By this simple change it becomes possible to convert almost any standard broadcast receiver into a supersensitive or DX receiver.

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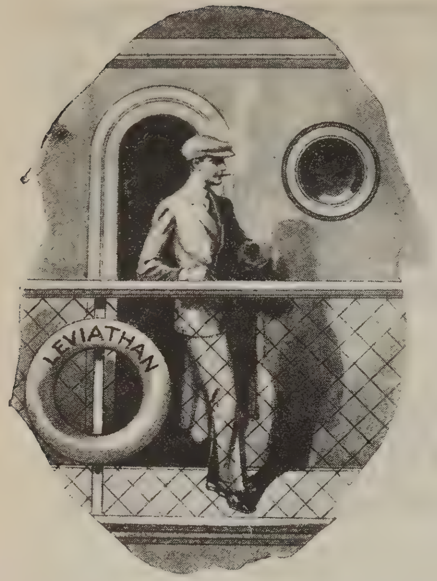

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Index to Advertisers

A PAGE
Abco Mfg. Sales Co. 1056
Advance Electric Co. 1049
American Technical Society 1048
Amperite Corp. 1052
Amplex Instrument Laboratories 1040
Amrad Corp. 1039
Autodyne Radio Co. 1053

B
Black, B. A. 1061
Blan the Radio Man 1062
Browning-Drake Corp. 1052

C
Central Radio Laboratories 1046
Chicago Gear Works 1052
Chicago Radio Apparatus Co. 1043
Chivily, Nicholas 1048
Classified Advertising 1064
Continental Wireless Supply Co. 1049
Cooke, L. L., School of Electricity 1065
Cornish Wire Co. 1052
Coyne Electrical School 1062

D
DeForest Radio Co. 975
Deutschmann Corp., Tobe 1046
Drake, Frederick J. & Co. 1042

E
Electrad, Inc. 1037
Electrad Forum 1056
Excello Products Corp. 1054

F
Federated Purchaser 1043
Find-All Radio Co. 1040
Funk Magazin 1060

G
Gottlieb, Edward 1056

H
Hammarlund Mfg. Co. 1047
High Frequency Labs. 1052
Hoodwin Co., Chas. 1047-1052

I
International Resistance 1050
International Typewriter Exchange 1065

J
J. M. P. Mfg. Co., Inc. 1056

K
Keeley Institute 1065

L
Lacey & Lacey 1052
LaSalle Extension University 1052
Lincoln Radio Corp. 1043

M
McGraw-Hill Book Co., Inc. 1050
Manhattan Electric Bargain House Co. 1063
Mason, Fenwick & Lawrence 1047
Merriam Co., G. & C. 1038
Meske, Arthur 1064
Metal Cast Products 1065

N
National Carbon Co., Inc. 1055
National Co., Inc. 1041
National Radio Institute .... Back Cover

O
Omnigraph Mfg. Co., The 1061

P
Pilot Radio & Tube Corp. .... Inside Back Cover
Plapao Co. 1062
Popular Homecraft 1066
Projectionist Sound Institute 1066

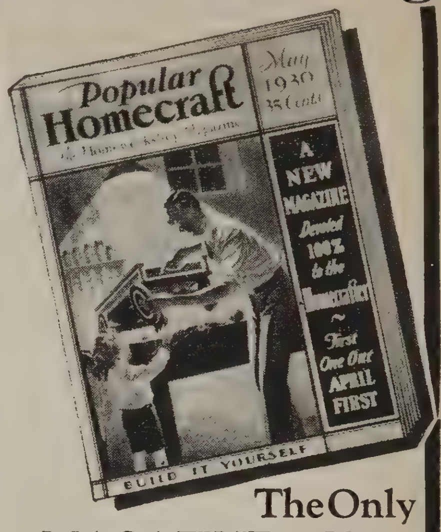
R
Racon Electric Co., Inc. 1036
Radio Doctors, Inc. 1062
R. C. A. Institutes, Inc. 1035
Radio International Guild 1059
Radio & Television Institute 979
Radio Training Ass'n of America 973
Radio Treatise 1044
Radio Wet Ground Mfg. Co. 1052
R. B. Specialty Co. 1052-1062
Rim Radio Mfg. Co. 1062
Roll-O Specialty Co. 1048
Royal Eastern Electric Supply Co. 1044

S
Samson Electric Co. .... Inside Front Cover
Scott Transformer Co. 1061
See Jay Battery Co. 1054
Silver-Marshall, Inc. 977
Smith Typewriter Sales Co. 1042
Sprague Specialties Co. 1038

T
Teleplex Co. 1038
Thomas, C. M. 1065
Townsend Labs. 1036
Triad Mfg. Co., Inc. 1057
20th Century Mail Order Corp. 1054

W
Wellston Radio Corp. 1049
Weston Electrical Instrument Corp. 1051
West Side Y. M. C. A. Radio Inst. 1047
Wiley, John & Sons 1063

Y
Yaxley Mfg. Co. 1062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(Technical School) .... (Correspondence Course) ....
Do you have your own business? .... Address ....
or by whom employed? .... Address ....
How long have you been in the Radio Business? ....
What technical magazines do you read? ....
What type of radio business do you conduct? (please check)
Repair .... Installation .... Sales .... Custom-built Sets ....
Do you make "public address" installations? .... What make? ....
Do you recommend any particular make of custom built kit set to your clients? ....
What make? ....
Are you the accredited agent of any manufacturer for servicing and repair? ....
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If so, what? ....
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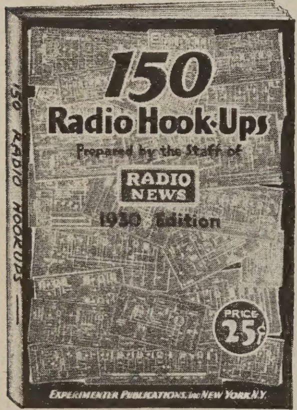
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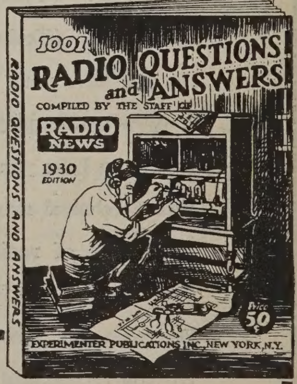
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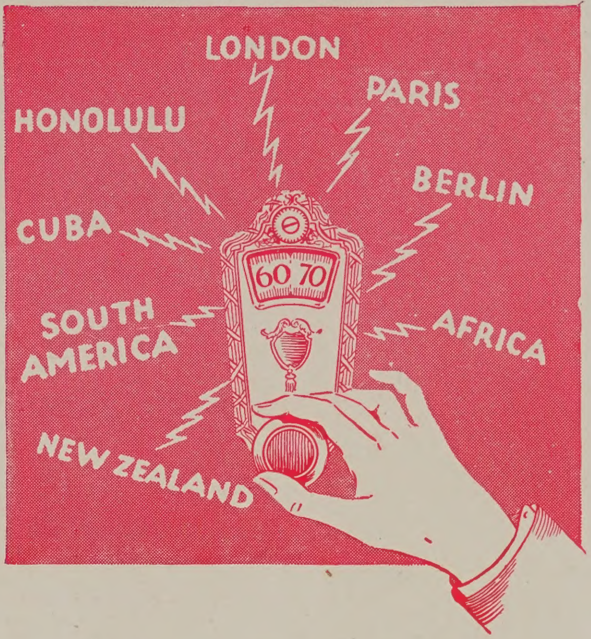
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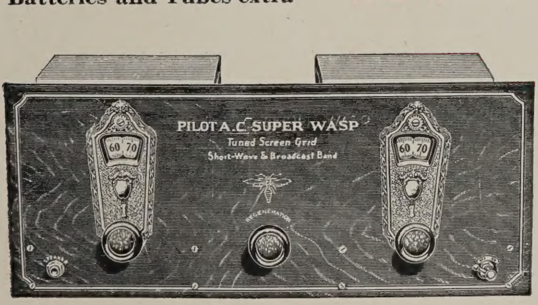
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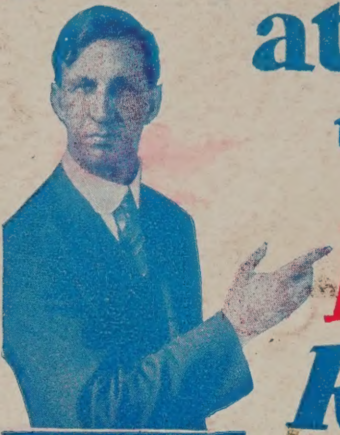

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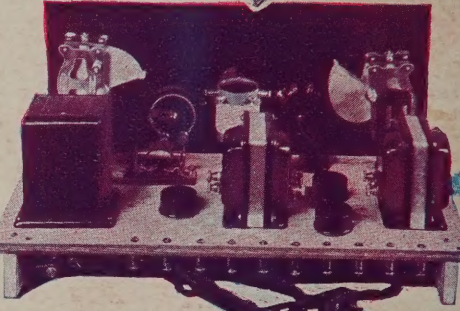

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